

Please Return Promptly



VOLUME 8 NUMBER 21

THE INDEPENDENT GUIDE TO IBM-STANDARD PERSONAL COMPUTING

DECEMBER 12, 1989

FIRST LOOKS

**The First 486 PCs
Hands-On: How Fast
Are They?**



CONNECTIVITY

**NetWare 386:
It's Here,
It's Sensational**

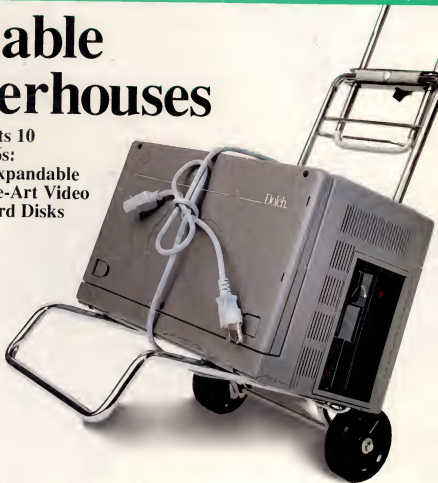
ADD-IN BOARDS

**PC Labs Tests
10 LIM 4.0 Memory
Cards for RAM-
Hungry Applications**

Portable Powerhouses

**PC Labs Tests 10
Do-It-All 386s:**

- Fast and Expandable
- State-of-the-Art Video
- Serious Hard Disks



We want you to
always view our monitors
in a certain way.



Introducing power,

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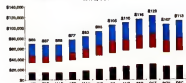
In the past 5 years we've grown from a local business with only a single office to a well-established operation with 30 offices throughout New England. An investment in Delman can assure a strong return for a wide variety of reasons.

Extensive research has shown that due to the high cost of new homes, the demand for high quality additions — built on to existing homes — is on the upswing. Delman Construction has established an excellent reputation as one of the premier addition builders in the marketplace. Here is the opportunity for a sound, profitable investment.

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DELMAN CONSTRUCTION - SALES TOTALS

Items By Month



DELMAN CONSTRUCTION



To: Staff
Re: We've adopted a new standard - Microsoft Works

Microsoft Works is the perfect product for our growing business. Here's why:

Online Help & Training Make Works Incredibly Easy to Learn and Use. Only Works provides such extensive help and online training from anywhere in the product at the touch of a single key.

Multiple Windows and WYSIWYG Style On-Screen Add Dramatic Visual Quality to Microsoft Works 2.0. With multiple windows, you can work with up to eight different files at once, side-by-side or overlapping — just as if they were on your desk. With WYSIWYG style, you can see text, tables, graphics and more on-screen.

Print Preview Lets You View Documents On-Screen. Preview footnotes, headers, footers, margins, page breaks, font sizes, graphs, and paragraph borders on-screen before you print.

Creates the Highest Quality Output. With Works you can easily merge text, tables, and charts into a single document, then print on any one of over 250 printers. Works even supports PostScript printers.

Manage Your Business Day with New Built-In File Management and Alarm Clock Utilities. Without leaving Works, you can perform eight DOS commands. And, with the new alarm clock & appointment manager, you can display a reminder message on-screen at any time.

Here's a Summary of the Features in Microsoft Works 2.0:

- 100,000 word spell-checker and 30,000 keyword thesaurus
- Footnotes and multiple long page headers and footers
- Pop-up calculator and numeric keypad
- Includes utilities to manage files and run other programs
- Paragraph borders for emphasis
- Create custom labels with the fast and flexible desktop
- Runs great with MS-DOS (or compatible) and with EGA compatible monitors
- Built-in macros to automate repetitive tasks
- Connect files to IBM 345 Word, WordPerfect, DisplayWrite, WordStar and more
- 256/640/1600 Lines 1-3 and MS-DOS compatible operation (WPS and WKS)
- Fast, fully multi-merge and scaling label generator
- IBM 327 and 4.0 expanded memory support
- Supports any of the popular networks including Novell and 3Com

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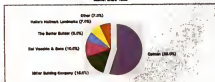
DELMAN CONSTRUCTION



DELMAN CONSTRUCTION - Keeneborough Office Revenue: Cost Breakdown

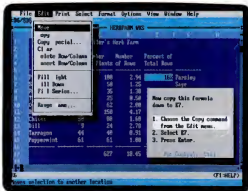
REVENUES	JAN	FEB	MAR	APR	MAY
ADDITIONS	\$14,500	\$13,800	\$18,900	\$27,600	\$32,370
Items Total	\$1,273	\$1,899	\$3,416	\$5,891	\$5,780
Roofs	\$265	\$248	\$271	\$517	\$394
Porches	\$363	\$360	\$365	\$306	\$355
Decks	\$395	\$413	\$377	\$712	\$627
Windows	\$194	\$100	\$201	\$109	\$399
Garages	\$737	\$401	\$898	\$1,117	\$1,450
Basements	\$221	\$252	\$278	\$749	\$362
TOTAL REVENUES	\$16,773	\$15,739	\$21,316	\$36,581	\$46,356
EXPENSES	JAN	FEB	MAR	APR	MAY
Supplies	\$1,349	\$1,812	\$1,220	\$1,529	\$2,525
Salary	\$1,050	\$1,050	\$1,050	\$1,050	\$1,050
Benefits	\$173	\$173	\$173	\$173	\$173
Rent	\$1,830	\$1,830	\$1,830	\$1,830	\$1,830
Insurance	\$390	\$473	\$902	\$940	\$1,056
EXPENSES	\$4,095	\$4,288	\$4,985	\$5,482	\$6,584
NET PROFIT	\$12,678	\$11,451	\$16,331	\$31,099	\$39,772

DELMAN CONSTRUCTION Market Share 1985

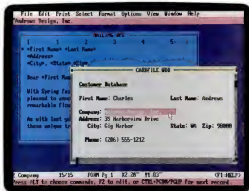


It's almost impossible to show you all the things new Microsoft Works 2.0 can do. So we'll tell you. (Hint: read the memo.)

in all its simplicity.



You can be working before you know it. Microsoft Works provides built-in help and training that takes you through each application, step-by-step.



Everything's easier when you can see what you're doing. With overlapping windows, Works lets you see up to eight different documents at the same time.

There are people who say that powerful software is too complicated to use. And others who say that simple software can never have enough power to meet your needs.

Fortunately, you won't find any of these people working at Microsoft.

Which brings us to new Microsoft® Works 2.0. Software that has all the powerful tools you need in one easy-to-use program.

You get business applications like word processing with a spelling checker and thesaurus, a spreadsheet with business graphics, a database with reporting and a communications module all rolled into one.

All are powerful enough to stand on their own, and handle whatever numbers, words and data you can throw at them.

At the same time, they're a piece of cake to learn and use.

For openers, only Works has built-in training to get you up to speed quickly.

Once you're started, you'll see that each application has the same look on-screen. Which means there's nothing difficult about moving back and forth between, say, your spreadsheet and your word processor. Then into your database. And back

out again. You can even move data between all the modules. Easily.

When you do have a question, it's simple to get an answer. Works provides help at the touch of a single key.

The end result is better-looking, more sophisticated output on everything: correspondence, marketing materials, sales information, financial data. Put together in an incredible variety of combinations with much less effort. And much more impact.

If you'd like to know more, call us direct at (800) 541-1261, Dept. K39. We'll answer your questions, in simple terms.

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Inside

This issue's feature on replacement keyboards represents a mild departure from *PC Magazine's* standard fare. In this story, we evaluate and criticize products for qualities that are largely subjective. We groped for ways to quantify and standardize the products, as is our habit, so that testing and observation could produce clear winners and losers. Alas, we discovered, it is impossible to measure with PC Labs tests a board's unique feel, or even to predict with

precision which keyboard will win the approval of the highest percentage of users.

Our solution? We decided to fight subjectivity with subjectivity. We borrowed a concept long employed by magazines like *Car and Driver* and *Road & Track*: the panel of experts. If we could assemble a representative group of serious PC users, we reasoned, their collective reactions to and impressions of the most-popular keyboards would be more informative than any test results or the opinions of any single reviewer.

Drumming up support for the idea and finding suitably opinionated experts proved to be no problem. Associate editor Kellyn Betts simply appealed to members of *PC Magazine's* diverse Editorial and Labs populace to join our would-be dynamic team. With minimal exhortation, as usual, our already overworked crew came through, finding the time to use and critique each of the four models we selected for review.



After a week of compiling the data from 40 completed scripts and 40 written reviews and identifying a consensus where one existed, we assembled the panel en masse for a free-wheeling discussion of each keyboard's strengths and weaknesses. We managed to agree on some baseline assessments, but the amount of discord we had to work through showed us just how personal the choice of a keyboard is.

Having staffers answer the call for

help is business as usual around here. Many of our feature reviews, not to mention First Looks and After Hours critiques, are written by curious Editorial and Labs staffers. As a rule, this type of activity is done on free time, above and beyond each person's regular duties.



PC Magazine's keyboard mavens: Bruce Brown, Joseph J. Antinori, and Kellyn Betts, in their own little world.

So while this issue's feature on replacement keyboards may seem a bit more lighthearted than usual for us, rest assured that our staff took very seriously its responsibility to bring you the most useful and honest report possible.

Also in this edition, take a close look at the biggest (and most powerful) portables on the market. They're 386 boxes running at 20 and 25 MHz and, if not exactly portable, they're luggage. If, by chance, you've got a nice luggage cart, one of these machines could make business traveling a lot more productive than it's ever been before.

—Joseph J. Antinori

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Graphics (1 pg)	0.23	0.23	0.54	
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Text + Graphics (1 pg)	0.90	0.90	1.36	
List Price	\$5,995	\$6,995	\$6,995	

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Lori Grum/ Giving your PC the power of a 386; programming with .PCX files.

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ALR and Hewlett-Packard introduce the first 486-based PCs. Are they too powerful for DOS? The 6-pound, 12-MHz **Compaq LTE/286** fits a big hard disk into a notebook-sized form factor.

OS/2 1.2 gets a High Performance File System, a revamped PM shell, and added utilities.

IBM enters the personal information management race with **IBM Current**.

Invisible RAM provides inexpensive memory management for 80286 and 80386 machines.

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Hard innovation.



COVER STORY

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20/20 Portable 386s: Over 20 Pounds, Over 20 MHz
Bill Howard/ These power portables give you everything you'd want in a high-end desktop PC. The field has expanded dramatically in the past year, though the contenders haven't benefited from the breakthroughs that have drastically reduced the weight of their less potent brethren.

116 Compaq Computer Corp.

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FEATURES

169 MEMORY BOARDS

A Slot Full of RAM

Edward Mendelson/ PC Labs can help you take advantage of today's multitasking environments with detailed testing and reviews of ten LIM 4.0 memory expansion boards. These boards can carry at least 8MB each and are optimized to work with environments such as Quarterdeck's **DESQView** and **Microsoft Windows**.

182 Features Table

190 Performance Tests

205 CONNECTIVITY

Building Workgroup Solutions: Novell's NetWare 386

Frank J. Derfler, Jr./ Novell's version of **NetWare** optimized for the i386 and i486 features incredibly fast performance and humongous-file-size support.

206 Features Table

210 Performance Tests


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 **PC Magazine** said it best when they presented the *Editor's*

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PC Magazine, October 17, 1989 Issue

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40 MB HD (28 ms 1:1)	\$1795	\$4250	\$4605
72 MB HD (28 ms 1:1)	\$2095	\$4495	\$4850
160 MB HD (18 ms ESDI*)	\$4795	\$5095	\$5295

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PC Magazine said, "Austin Computer Systems has a winning combination of classy parts, smart design, high performance, and aggressive pricing, all backed by a GE on-site service contract. How can you lose?"

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72 MB HD (28 ms 1:1)	\$1995	\$2295	\$2395

AUSTIN 286/16 WITH 1MB RAM			
Choose Hard Drive	Choose Monitor Below		
	VGA	VGA Color	VGA Color
	Phosphor	(640 × 480)	(800 × 600)
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- 2 Serial Ports & 1 Parallel Port
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- American-Made MotherBoard
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Everex's 386SX-based system offers two extras



August 1989 Everex STEP 386is

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Letters

A (DIR)MATCH MADE IN HEAVEN

Once again, *PC Magazine* has provided more value to me and my employer than the price of a subscription.

For all the editorial ballyhoo about 386s, OS/2, and so forth, you guys still provide the best source of powerful, free software around for cheap PCs. Michael Mefford has saved us a bundle in the last couple of years, and DIRMATCH (Utilities, *PC Magazine*, September 26, 1989) really fills a niche around here. I have long suspected that the guys in your PC utilities group are running a counterculture guerrilla base dedicated to proving that XT's are still worthwhile investments. Viva la revolución!

Gary Flispart
New Albany, Indiana

I'd like to thank *PC Magazine* and Michael Mefford for DIRMATCH. This is the first utility you have published in quite some time that really "knocks my socks off." Everybody needs this one, whether they know it yet or not. My first reaction after I read the introduction to the program was, "Why didn't anyone do this before?" Why didn't I do this before?

Bill Hankins
Matawan, New Jersey

THE GUI: BEAUTY ONLY SKIN DEEP?

So tell me: Why the hue and cry for the graphical interface ("The GUI: An Interface You Won't Outgrow," *PC Magazine*, September 12, 1989)? Its hardware demands are large, its I/O is demonstrably slow, and its greatest appeal is to the visually oriented (I'm a musician myself, and take umbrage at the popular notion that music equals pictures). Basically, I'd rather not buy a 386, I need the fastest I/O possible, and I don't want to have to figure out everyone's latest pictorial representations of vocabulary.

Advocating the GUI is like telling me to slow down for pretty pictures. You're a little confusing here: you strenuously pro-



mote faster hardware, yet you want users to accept a sluggish interface. I don't suppose you could coerce manufacturers into giving us the best of both worlds?

Dave Phillips
Findlay, Ohio

Jim Seymour's article "The GUI: An Interface You Won't Outgrow" is excellent. He has given me an understanding of graphical interfaces that I have longed for. One point does confuse me, though.

The sidebar on page 104 ("Where the Apps Are and Where They're Going") states that "the accompanying diagram includes the products *PC Magazine* editors consider the best in each category." Then under "Database," *Paradox* is listed. But in the November 15, 1988, issue of *PC Magazine*, in an article entitled "Same Time, Same File: Programmable Databases for LANs," *DataEase LAN* and *Clarion Professional Developer* are your Editor's Choices.

I don't mean to nitpick here, but now *Paradox* seems to be your DBMS of choice. James B. Dunlop
Atlanta, Georgia

To illustrate the increasingly graphical nature of the PC, *PC Magazine* chose for the chart in question products that provide technical and performance leadership; we indicated whether they have or will have graphical interfaces. Selection criteria included (but wasn't limited to) Editor's Choice and Awards for Technical Excellence designation, plus the opinions of *PC Magazine* editors (in fact, in the September 26, 1989, issue of *PC Magazine*, *Paradox 3.0* was indeed our Editor's Choice).—Ed.

CONSTRUCTIVE CRITICISM

We applaud *PC Magazine* for its feature on multiuser accounting packages ("LAN Accounting Software: Up to Speed on the PC Platform," *PC Magazine*, September, 26, 1989).

Each review in the story gives the reader a different view of some important aspect of the products, such as functionality, ease-of-use, flexibility, adaptability, fault tolerance, and support. It is virtually impossible for a single review to effectively address all of these issues. Furthermore, *PC Magazine* included much more rigorous performance testing than any previous *PC* accounting review. In fact, the tests revealed some characteristics of our product, *Solomon III*, that led to less than optimal performance in the tested version. As a result of this information, we have identified ways to significantly, and in some cases dramatically, improve *Solomon's* performance. These changes have been incorporated into Version 6.0, *Network Solomon III*.

Gary M. Harpst
President
TLB Inc.
Findlay, Ohio

AN R:GUMENT FOR R:BASE

Alfred Poor's evaluation of *R:BASE* for DOS ("Multiuser Databases: The Art of Simultaneous Access," *PC Magazine*, September 26, 1989) suggests that *R:BASE's* "warts" make this database far

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Letters

more difficult to use than the other products reviewed. This is far from the truth. These "idiosyncrasies" actually make *R:BASE* much easier to work with than competing databases.

For example, having all the database files ("tables") plus all of the indexes in three DOS files is a tremendous advantage, not a disadvantage. Since *R:BASE* can have 80 tables open simultaneously with up to 800 columns indexed, I prefer to have three files containing all this data instead of 880 files showing up in my sub-directory.

What's more, Mr. Poor's description of how to create a compound index sounds as if this is a tedious task at best, when in reality it takes just a few keystrokes. In fact, I have yet to see anything easier in a competing product.

Mark Ciampa
Gallatin, Tennessee

SILICON BRUTALITY

PC Labs has not done a long-term reliability test of computers and components since I've been reading the magazine (about nine months). To remedy this situation, I suggest adding an entire subdivision to PC Labs that does nothing but brutalize machines and components. This would require a long-term investment in time and would result in features less "up to the minute" in nature, but would nonetheless provide a great service to all regular *PC Magazine* readers.

Phineas Filligan
Oklahoma City, Oklahoma



PC Magazine plans to report on the long-term reliability of PCs, printers, monitors, and components beginning in the January 16, 1990, issue. Later in the year, we'll devote a single issue to the topic.—Ed.

SAY IT ISN'T SO

In the July 1989 issue of *PC Magazine*, Coming Up admits that "not just for beginners, BASIC is known and used by more people than is any other PC programming language." The article goes on to state that BASIC is "easier to learn and ultimately more powerful than" other high-level languages such as C or Pascal.

Nonetheless, in the introduction to the August 1989 utility, you state that you

"regret that the length of most high-level language programs will preclude our printing .BAS listings that could be typed to create .EXE files." It was notable that the utility program listing for that issue consisted of only four pages of code.

Furthermore, the utility in the September 26, 1989, issue contained no .BAS listing even though the source was an .ASM file, not a "high-level language."

This suggests that *PC Magazine* is deserting BASIC despite its popularity and power. Perhaps you do not recognize that many personal computer users use only BASIC and do not have modems with which to download programs from electronic bulletin boards.

Robert E. McCoy
Nea Filadelfia, Greece



An HLL such as C creates much larger executables than an equivalent MASM or TASM file. The BASIC listing that would have resulted from the code mentioned in this letter would have taken up a significant amount of space that we did not have available. Space constraints forced us to drop the other program listings mentioned. Unfortunately, magazine pages

I can see it all now.

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of PC Magazine tucked

under their arms.

are a limited resource, and more and more of them will need to be devoted to text. The price of 1200 baud modems has dropped significantly, making PC MagNet the best means for us to deliver source code and executables. *PC Magazine* is also happy to send printed source code and BASIC listings to anyone who needs them. Simply send a stamped, self-addressed envelope to Carolyn Falconer, *PC Magazine*, One Park Avenue, New York, NY 10016. Make sure to include a cover letter listing the specific issue and program in question.—Ed.

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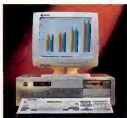
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Letters

SELF-SERVICE?

After praising his favorite computer salesman in the September 12, 1989, issue of *PC Magazine*, Jim Seymour asserts that "...what sounds magical in the PC business is the norm in many other fields...." Okay, Jim, what fields? You can buy a car today—or a TV, VCR, or CD player—and receive no service whatsoever. Service, like courtesy, is fading from society like Lewis Carroll's Cheshire cat.

Michael H. Dougherty
High View, West Virginia

I can see it all now. A rash of pseudocustomers coming into my store with the latest copy of *PC Magazine* tucked under their arms. Instead of asking about an obscure product that may have appeared in one of your advertisements, they will be following William F. Zachmann's advice to pretend they are customers. So when a bona-fide customer comes into my store, my salesperson will be engulfed in solving some silly technical riddle for a person who has no intention of buying anything.

Unlike the computer stores that were described in your magazine, the Canadian way of doing business is much different. Fierce competition keeps our margins very narrow and the level of our service very high.

Don Luscombe
London, Ontario
Canada

FIVE AGAINST ONE IS A FAIR FIGHT

In his article on the 80386 CPU (*Power Programming*, *PC Magazine*, September 26, 1989), Ray Duncan's explanations of some of the hardware details of that chip are clear and well written (which immediately makes him ineligible to write technical manuals for Intel).

However, in his comparisons of DOS, OS/2, and Unix, Mr. Duncan ignores some critical distinctions and implies that others do not exist. In particular, it should be noted that Unix is a multiuser system while OS/2 and DOS are single-user systems. Therefore, one needs to be careful when comparing hardware and software costs of these environments. While it is true that Unix requires more memory and disk space than OS/2 and DOS, and also that Unix system and applications software is more expensive than its OS/2 and DOS counter-

parts, these costs are amortized over several users. To be fair, Mr. Duncan should compare the hardware and software costs and capabilities of several DOS or OS/2 systems networked together, versus one Unix system. I think he will be surprised with what he finds.

Tom Bishop
Project Manager
Unix International Inc.
Parsippany, New Jersey

CORRECTIONS & AMPLIFICATIONS

The record- and file-locking capabilities of Clarion Professional Developer ("Multiuser Databases: The Art of Simultaneous Access," September 26, 1989) were described incorrectly. All the statements in Clarion that affect data encryption and file sharing are produced automatically by its application generator (Clarion Designer).

When a workstation calls for a record, the program displays it, saving a copy in memory but not locking it. When the user presses the "save" key, the program locks the record, reads it, and compares it with the retained copy. If the retained copy is identical to the saved copy, it is updated and rewritten. If the record has been changed, it is unlocked and re-displayed along with a message explaining that the record has been changed. Updates to records that have been changed do not get lost, and therefore there is no locking limitation, as was stated.

In the September 12, 1989, Advisor column, it was erroneously reported that Gibson Research's SpinRite cannot low-level-format RLL drives. SpinRite is in fact fully compatible with RLL drives.

DOS uses approximately 60K of RAM, not 16K as stated in the August 1989 Advisor column.

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— PC Week, Apr. 10, 1989

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w/48MB (20ms) & 1.1 Interface	\$1899	\$2048	\$2198	\$2498
w/80MB (20ms) & 1.1 Interface	\$2249	\$2298	\$2448	\$2748
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CPU	80386	80386	80386SX	80286	8088-1
Speed (MHz)	33/9	20/9	16/9	12.5/9 25	10/4.77
BIOS	Phoenix	Phoenix	Phoenix	Phoenix	Phoenix
Norton SI Rating v.4.0	41.8	22.0	17.6	12.3	2.1
Standard Memory	1MB	1MB	1MB	512K	640K
Shadow BIOS	Yes	384K	Yes	Yes	—
Memory Upgrades	2, 4, 6, 8, 16, 32, 64, 128, 256, 512, 1024, 2048	2, 4, 6, 8, 16, 32, 64, 128, 256, 512, 1024, 2048	2, 4, 6, 8, 16, 32, 64, 128, 256, 512, 1024, 2048	2, 4, 6, 8, 16, 32, 64, 128, 256, 512, 1024, 2048	—
Coprocessor Support	80287 or 80387	80287 or 80387	80387SX	80287	8087
Expansion Slots: 32-bit	1	1	—	—	—
Expansion Slots: 16-bit	5	4	6	6	—
Expansion Slots: 8-bit	2	3	2	2	8
Dual HD/FD Controller	Yes	Yes	Yes	Yes	w/FD optional
5.25" Floppy Drive	Standard	Your Choice	Your Choice	Your Choice	Standard
3.5" Floppy Drive	Standard	Standard	Standard	Optional	Optional
Device Bays (of optional Harddisk)	0 Flop, 1 Hard	1 Flop, 1 Hard	1 Flop, 1 Hard	1 Flop, 1 Hard	1 Flop, 1 Hard
Serial Ports	2	2	1	1	1
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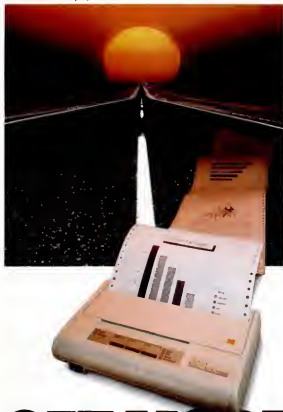
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November 14, 1989
Note: Diconix 150 plus

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by Lori Grunin

Advisor

C PROGRAMMING WITH .PCX FILES

I am in the process of developing some C applications that require reading graphics images created in the .PCX format. The problem I am having is finding out the exact format for .PCX files. I have explored various books and publications but have had no luck. Where can I find this documentation? Is there some type of industry standard that has been published?

Paul D. Wykes
Leicester, Massachusetts

PC Little did you know that the information you need is just a phone call away! ZSoft (450 Franklin Rd., #100, Marietta, GA 30067; (404) 428-0008), originators of .PCX files, freely distributes the technical documentation for the .PCX file format; all you need to do is call up the sales or technical support staff and request a copy.

You may not need the specs if you want to read the files just to display the images or to get information from the headers. Genus Microprogramming sells the *PCX Programmer's Toolkit* (\$195, \$495 with source code; 11315 Meadow Lake, Houston, TX 77077; (800) 227-0918, (713) 870-0737), which consists of 62 functions and 9 utilities that allow you to display images from, and save them to, memory and disk. They also let you access and manipulate the information contained in the file headers.

In addition to supporting several different C compilers, the toolkit can be used with BASIC, Pascal, FORTRAN, ASM, and Clipper. Graphics resolution support extends up to 800 by 600 at 256 colors. You don't pay royalties to use the code.

The company also offers two companion packages: *PCX Text*, which allows you to accept and display strings and to manipulate fonts, and *PCX Effects*, which lets you add effects such as fades, explodes, and splits to the images. These packages are \$99 each (or \$199 each with source code).

■ **C PROGRAMMING WITH .PCX FILES:**
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■ **PC-TO-THE-MAX:**
Turning a PC into an 80386 system—almost.

PC-TO-THE-MAX

Recently my uncle gave me an IBM PC with only 256K of memory and a single floppy disk drive. I want to upgrade it to a 386 with a clock speed of at least 16 MHz and with 2MB of memory. I also want to add a hard disk (at least 60MB) and another floppy drive. What would be the least expensive way to do this?

Yeocyea Argus
Milpitas, California

PC You've got three options, each of which has its drawbacks and advantages: you can get an 80386 accelerator card, replace the PC's motherboard with an 80386-based one, or scrap the machine altogether and get a real 80386-based system.

Although in the short run you may feel that the least expensive solution is the correct choice, you should think hard about what your future needs might be; compare, for example, pouring \$2,000 into a machine that you could outgrow in two years with spending \$3,200 on a system that offers sufficient expandability. Also keep in mind that 2MB of RAM might seem like an awful lot next to the 256K you've got now, but it will feel hopelessly confining if you ever want to do things like multitask or work with large images. On the other hand, if you buy quality components now to put in your PC, you can transfer them when you eventually decide to buy a new machine.

First, the technical issues. If you go with anything less than a totally new machine, you'll only have five expansion slots, as opposed to the eight slots found in a typical desktop 80386 system—and remember that you lose two slots right off the bat, one to the video board and one to the I/O card (which includes your serial and parallel ports). You might also occasionally run into cards that are too high for your PC's chassis, since the AT chassis is slightly taller.

Since an accelerator card occupies one of the PC's expansion slots, that reduces your number of available slots to two. Furthermore, neither of those slots will be 16- or 32-bit, and you run a greater risk of installing a card in one of the slots that conflicts with the accelerator board than if you replace the motherboard. Although the 80386 processor will give you much higher throughput than the 8086 currently in the machine, it won't be nearly as fast as it would be in a different configuration.

Accelerator cards, such as the highly recommended Inboard 386/PC (Intel PCEO, 5200 NE Elam Young Pkwy., C03-07, Hillsboro, OR 97124; (800) 538-3373, (503) 538-3373), can hold a maximum of 5MB of memory. To install more, you have to give up another slot to an 8-bit memory board. Nor will the board support OS/2, although you will be able to use *Microsoft Windows/386* and *DESQview* to multitask.

On the other hand, replacing the motherboard gives you 16- and 32-bit slots, a faster bus speed, and a little more room for memory expansion.

Now that we've got the technical details out of the way, let's look at the relative expense of each of the alternatives. You can get a reliable mail-order 16-MHz 386 machine with 2MB of memory, a 60MB ESDI hard disk drive, a VGA video board, and a color monitor for about \$3,200.

Why compare a system with VGA with one that has CGA or monochrome (as your PC probably does now)? Because if you buy a new machine, you shouldn't

Advisor

settle for anything less than VGA resolution, especially since you can get a VGA card and a monochrome display relatively inexpensively.

How much will it cost to piece together a system? (Note: these estimates are based on averages of a totally unscientific, barely random sample of mid-September mail-order prices for midrange components; they are presented strictly for comparison.) The Inboard 386/PC comes standard with 1MB of memory, and although it retails for \$895, you can buy it for about \$600 from many mail-order houses. The 2MB piggyback module populated with 1MB of memory adds another \$495 (or \$350 via mail order).

A half-height, 60MB, ESDI RLL hard disk drive can be found for around \$500, and a half-height, 5.25-inch, 1.2MB floppy disk drive for another \$100. You'll also need a replacement controller, which costs about \$150. It's a good idea to replace your current power supply with a 150-watt one, which you can get for \$60.

That's an estimated outlay of less than \$1,800 for your stated needs.

Although motherboards that fit into the PC's chassis aren't too plentiful, Hauppauge Computer Works' 386 Moth-

On a "dollar-only" basis, the accelerator solution is obviously more cost-effective than replacing the motherboard.

lated with 1MB of memory retails for \$525 (\$460 by mail order). An 8MB adapter is also available. Adding the drive, power supply, and controller prices that I mentioned earlier, the total comes close to \$2,600.

The costs of an 8-bit VGA video card (\$250) and an analog color display (\$500) bring the price of the accelerator and motherboard upgrades to \$2,510 and \$3,315, respectively. (A monochrome VGA display would reduce the total cost by about \$200.)

So on a "dollar-only" basis, the accelerator solution is obviously more cost-effective than replacing the motherboard. If you opt to buy a new system, there are plenty of charitable organizations around that need the equipment, and you can take a tax deduction on the machine to the extent that the law allows.

ASK THE ADVISOR

Send your questions to Advisor, *PC Magazine*, One Park Avenue, New York, NY 10016, or upload them to PC MagNet (see the "By Modem" sidebar in the Utilities column for access information). Please specify your equipment. ■

erboard PC16 (175 Commerce Dr., Hauppauge, NY 11788; (800) 443-6284, (516) 434-1600), for example, comes with 1MB of RAM for \$1,395 retail (\$1,295 by mail order). The 2MB expansion board popu-

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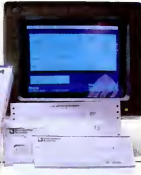
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PC Magazine, May 30, 1989

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Performance Comparisons using PC Labs Benchmark Series Release 4:

	80386 Instruction Mix	Floating Point Calculation	Conventional Memory
ZEOS 386/16 Desktop	3.58	13.62	0.58
ZEOS 386/20 Desktop	2.87	10.62	0.38
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Compaq Deskpro 386/16	4.12	15.67	0.75

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Performance Comparisons using PC Labs Benchmark Series Release 4:

	80386 Instruction Mix	Floating Point Calculations	Conventional Memory
ZEOS 386/25 Desktop	2.29	8.37	0.33
ZEOS 386/33 Desktop	1.67	6.43	0.27
IBM PS/2 Model A	2.27	8.33	0.60
Compaq Deskpro 386/25	2.36	8.59	0.37

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First Looks

Hands-on Reviews of the Latest Products

First 486 Machines Offer Minicomputer Power

PREVIEW
by John Dickinson

Unless you've spent solitary time on a minicomputer, you haven't experienced anything like the new breed of 80486-based PCs.

Intel's 80486 chip is the most clever and capable microprocessor yet developed for the legendary line of 80x86 chips, which have defined the IBM PC hardware standard. The 486 is more integrated and faster than any other CISC (complex instruction set computer) microprocessor. It combines the capabilities of an enhanced 80386,

equally fast 80387 math coprocessor companion, a sophisticated cache controller, and 8K of supporting static cache memory. All of this power and more is built into the 1,180,235 transistors housed in a piece of silicon less than one square inch in size.

The PCs built around the 486 come in three basic designs. ALR was the first to announce a 486-based PC. The company's PowerCache/4 employs IBM's Micro Channel architecture (MCA) bus design. Hewlett-Packard then announced the Hewlett-Packard Vectra/486, a 486 machine based on the Extended Industry Standard Architecture (EISA) bus design developed by Compaq and the "Gang of Nine." ALR also has an EISA entry, the ALR PowerCache/4e. Other companies are preparing to announce similar full-scale 486s—most based on the EISA bus—but only ALR and Hewlett-Packard had pre-production models of their 486-

based PCs available for preview in this article.

A third type of 486 machine is what might be called a *modified other platform* design, or *MOP*, PC. In this type of machine, one processor—typically an 80386—is replaced with an 80486 processor in an Industry Standard Architecture (ISA) or MCA design. Examples of this type of machine include the IBM Model 70-A21 with the optional IBM Power Platform, the Everex Step 486, and the ALR PowerFlex with the optional 486 daughtercard in-

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Notebook-sized Compaq LTE and LTE/286 Set New Laptop Standard

HANDS ON
by Mitt Jones

You have good reason to celebrate if you've resisted the allure of the notebook-sized laptop this long. Compaq's LTE and LTE/286 should be thought of not only as the only notebook laptops powerful enough to compete with full-sized portables, but also as the only full-powered portables small enough to be taken everywhere you go.

Though 1.9 inches thick—half an inch thicker than both the NEC UltraLite and the Zenith MinisPort—the LTE mod-

els measure only 11 inches wide and 8.5 deep, a size truly deserving of the notebook moniker. The differences between the LTE and the LTE/286 rest primarily with the choice of processor. Based on the 80C86, the \$2,399 LTE runs at 4.77 and 9.54 MHz. The \$3,899 LTE/286, based on the 80C286, runs at 8 and 12 MHz. Externally, and in most standard features and options, the two machines are identical.

Of the machines' many assets, the 3.5-inch floppy disk drive and the optional hard disk rank high on the list. Compaq's

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The HP Vectra/486's memory design is based on a high-speed burst memory controller.

PHOTOGRAPH BY TERRY OGDON

First Looks

Compaq LTE/286

CONTINUED FROM PAGE 33

secret is simple: the drives, which are positioned along the front edge of the machine, measure only three-quarters of an inch high. Manufactured by Conner Peripherals, the downsized hard disks boast a 1:1 interleave and an average random seek time of 29 milliseconds.

Compaq offers a 20MB version of the disk for the LTE and 20MB and 40MB versions for the more-powerful LTE/286. The 20MB version in our evaluation unit, an LTE/286, made an audible whirring noise, but the annoying grinding you often hear with laptop drives was mercifully absent.

The LTE display, undoubtedly the machines' second most valuable asset, measures slightly less than 9 inches diagonally

and all of a quarter-inch thick. Jointly developed with Citizen, the screen uses supertwisted LCD panels with electroluminescent (EL) backlighting. The technology is the same used in the UltraLite, and in both machines it creates a wonderfully readable screen. The viewing area measures a comfortable 7.7 inches wide by 3.7 inches high. As with its two notebook-sized rivals, the LTE supports CGA graphics with a resolution of 640 by 200 and four shades of blue.

Both the LTE and the LTE/286 come standard with 640K RAM, and each makes room for additional memory via a small option card. The LTE will accommodate a 1MB memory module, and the LTE/286 will accept either a 1- or 2MB version. Both machines support LIM 4.0 using Compaq's expanded memory manager.

A second option connector accommodates either a 2,400-

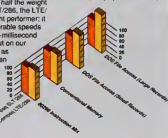
The Compaq LTE/286 packs a 20MB or 40MB hard disk in a notebook-sized form factor.



BENCHMARK TESTS: COMPAQ LTE/286

Although less than half the weight of the Compaq SLT/286, the LTE/286 is no lightweight performer; it doesn't take comparable speeds out of the same 29-millisecond 20MB hard disk, but on our tests it did perform as well as or better than most of the 286-based laptops evaluated in the July 1989 issue of *PC Magazine* ("286 Laptops Compute on Route").

Relative Time
(Compaq SLT/286 = 100)



Performance Time (Times given in seconds)	80286 Instruction Mix	Conven- tional Memory	DOS File Access (Small Records)	DOS File Access (Large Records)
Compaq SLT/286	6.04	0.87	63.81	5.98
Compaq LTE/286	6.13	0.94	77.82	8.15

The 80286 Instruction Mix benchmark series of tasks specific to the 80286 chip. Since this test shows the CPU operates in the context of the bus, processor, system memory, and motherboard architecture, a faster time means better overall computer performance.

The Conventional Memory benchmark test measures the read/write speed of the first 640K of memory. Slower relative times can indicate the presence of memory wait states or memory chips rated at slower access speeds.

The DOS File Access (Small Records) benchmark test times disk throughput as a

result of mechanical disk drive speed, hard disk controller function, and bus speed. The test is performed without software disk caching. Fast times are advantageous for programs that work with many short segments of data.

The DOS File Access (Large Records) benchmark test times disk throughput as a result of mechanical disk drive speed, hard disk controller function, and bus speed. This test minimizes the effect of small hardware caches on disk subsystem performance. It is performed without software disk caching. Fast times are advantageous when large files are loaded.

bit-per-second modem or an additional serial connector. A panel along the back of the machine conceals not only a standard-equipment serial port but also a parallel port, external storage module and CGA monitor connectors, and the connector for the optional numeric keypad.

In a step that should endear the LTE/286 to the number crunchers among us, Compaq also managed to make room for an optional 12-MHz 80C287 math coprocessor, though you'll have to partially disassemble the machine if you want to add it yourself.

Items like modems, hard disks, and backlit screens can use a lot of energy, leaving one to wonder whether the LTE can survive independent of a power outlet long enough to crunch many numbers. Fortunately, the answer is an unqualified yes.

Compaq rates the removable nickel-cadmium battery pack at 3.5 hours, a figure that seems conservative from our tests. Our evaluation unit—loaded to the hilt with a 20MB hard disk, 2,400-bps modem, math coprocessor, and 2.6MB of

RAM—allowed more than 4 hours of mixed use before issuing its low-battery warning. After the warning, the battery still packed enough power to run the machine an additional 33 minutes.

Compaq's power-conservation features undoubtedly help extend the battery life. Automatic routines, which can be adjusted or disabled via the setup program, place specific components or the machine as a whole in a standby, low-power mode after a set period of time. For example, in the default setting, the hard disk stops spinning after 2 minutes of inactivity.

If all system components remain inactive for a set period of time—10 minutes is the default—the entire system goes into standby mode, reducing power consumption to about three-eighths the normal level. A Standby button, inset above the keyboard, allows you to bring the machine back to its normal operating conditions—without losing data, of course. The button also allows you to put the machine into

CONTINUES ON PAGE 36

First Looks

Compaq LTE/286

CONTINUED FROM PAGE 34
standby mode manually.

For those not averse to toting an additional 1.5-pound battery pack, Compaq makes replacing the battery a breeze. The nickel-cadmium pack slides into a snap-shot compartment toward the rear of the left edge of the machine. An optional external quick charger can replenish the battery in about 1.5 hours. The standard-equipment AC adapter-charger weighs 9 pounds.

Other options include both 360K and 1.2MB external floppy disk drives, an automobile power adapter, an external DC2000 tape drive, and, of course, DOS 3.31 or 4.01, neither of which comes standard. Perhaps the handiest option of all is the padded carrying bag, which makes room for the laptop, a spare battery pack, the AC adapter, and miscellaneous briefcase items. A small, no-frills slipcover comes standard with each machine.

About the only place where Compaq made obvious compromises is the keyboard. Though very good overall, with full-sized alphanumeric keys and a firm, clicky feel, the keyboard suffers from a couple of oddities. The most bothersome is the layout of the arrow keys: the Up and Down Arrow keys, which are usually arranged one below the other between the Left and Right Arrow keys, are to the far right. You might eventually grow accustomed to this layout, but it will definitely take some time.

Another minor complaint concerns the weight of the machines. In their base configurations, the LTE and LTE/286 weigh 6.2 pounds each. Add a hard disk and that figure jumps to 6.7 pounds. By the time you add a modem, coprocessor, and 2MB of RAM, the machine weighs over 7.5 pounds, which is substantially heavier than the UltraLite's 4.4 pounds.

But this is still a minor complaint. If you can live with the UltraLite's 2MB RAMdisk, go ahead. If you want a real hard

disk and 3.5-inch floppy disk drive, the LTE is by far the smallest and lightest machine you'll find. The optional carrying case, loaded with the machine, an extra battery pack, the AC adapter, a phone cord, and a few thin manuals, weighs about 13 pounds—light in contrast to other similarly equipped machines.

Of course, all the technology in the world doesn't do much for you if you can't afford it, and neither the LTE nor the LTE/286 come cheap. Add the 20MB hard disk at \$600, the 2,400-bps modem at \$449, and DOS 3.31 at \$120, and you're up to \$3,568 for the LTE and \$5,068 for the LTE/286.

If you don't want to spend that kind of money, don't go near one of these machines, because you'll be writing out a check before you know it. The Compaq LTE and LTE/286 are, without reservation, the most exciting and usable laptops on the market. ■



Compaq LTE
Compaq LTE/286
Compaq Computer Corp.
20555 SH 249, Houston, TX
77269-2000; (713) 370-0670.
List Price: LTE Model 1, with 640K RAM, 3.5-inch floppy disk drive, \$2,399; LTE Model 20, with 20MB hard disk, \$2,999; LTE/286 Model 1, with 640K RAM, 3.5-inch floppy disk drive, \$3,899; LTE/286 Model 20, with 20MB hard disk, \$4,499; LTE/286 Model 40, with 40MB hard disk, \$4,999; DOS 3.31, \$120; DOS 4.01, \$150; MS OS/2 1.1, \$340; carrying case, \$89; additional battery pack, \$129; external fast charger, \$199; expanded memory board for LTE, \$349; 1MB memory board for LTE/286, \$699; 2MB memory board for LTE/286, \$1,299; 80C287 math coprocessor for LTE/286, \$799; 2,400-bps internal modem, \$449; external numeric keypad, \$119; automobile adapter, \$129.

In Short: Two revolutionary, notebook-sized laptops, each featuring a standard 3.5-inch floppy disk drive, room for an optional 20MB or 40MB hard disk, an excellent backlit screen, and a 3.5-hour removable battery pack.

CIRCLE 448 ON READER SERVICE CARD

486 Machines

CONTINUED FROM PAGE 33

stalled. (For more information, see the sidebar "486 Turbo Cards Come From Surprising Sources.")

Obviously, these new full-scale 486 computers are not meant to be DOS-based machines. They run DOS applications, and they run them reason-

ably fast—about 10 percent faster than a 33-MHz 386-based PC, according to the PC Labs benchmark tests. However, with prices ranging from \$10,000 to just under \$20,000 for the Vectra/486, the speed alone may not justify the high cost if all you're going to do is run standard business applica-

CONTINUES ON PAGE 36

486 TURBO CARDS COME FROM SURPRISING SOURCES

by John Dickinson

Turbo cards that modify PCs and improve system performance are nothing new. As far back as the Apple II days, Z80-based CP/M cards let those venerable machines run *WordStar* and other software packages made for Intel and Zilog processors.

However, you're more likely to remember the more recent crop of 80286-based turbo cards that transform XTs into fast ATs, and the similar slew of 80386-powered cards that turn XTs and ATs into hot 386-based PCs.

Now 80486-based cards have hit the scene, transforming 286- and 386-based PCs into 486 machines. However, this new breed of turbo cards is different because the cards have been engineered as upgrades to existing PCs by the original designers, not by option manufacturers.

There are some surprising participants in the 486 turbo-card business. Standing out among this group of hot rodders is IBM. It turns out that IBM is expressing 486 compatibility with its predecessors better than any of the other vendors in this market.

The IBM PS/2 Model 70-A21 was originally designed with a processor deck that contained the 25-MHz 80386, the 82385 cache controller and supporting static RAM cache, and a socket for the optional 80387 math coprocessor. Those are the elements that make up the single-chip 80486

solution, albeit with an 8K cache rather than the 64K cache housed on the processor deck of the original IBM PS/2 Model 70-A21.

IBM merely replaced the hardware on the processor deck with a 486 chip, renamed it the IBM Power Platform, and created a nice but expensive option for the Model 70-A21. The \$3,995 solution was so simple to build that IBM demonstrated the Power Platform in its hotel suite as Intel was announcing the 80486 at Spring Comdex.

ALR's solution is equally elegant and gives buyers of its PowerFlex a lot of room for processing growth. The PowerFlex begins life as a simple, 12.5-MHz 80286 machine priced at \$1,495. However, by installing the company's \$395 80386SX feature card, you can convert the machine into an inexpensive SX solution.

Then for \$1,895 you can tuck an 80486-powered feature card into the PowerFlex and have the least expensive 486 on the market. It doesn't perform nearly as well as ALR's full-scale 486 line—largely because the memory accesses are multiplexed down to the 16-bit bandwidth of the ISA memory bus. Then again, it costs only one third as much as the full-scale models.

Everex and AST have entered the race with 486-bearing cards that plug into the 386 sockets on their 25- and 33-

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First Looks

486 Machines

CONTINUED FROM PAGE 35
tions like *WordPerfect* or *Lotus 1-2-3*.

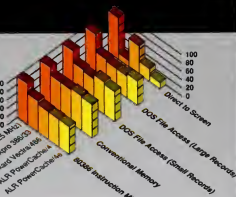
Furthermore, the DOS test results indicate that these 486 machines don't perform as fast as Intel had promised the new processor would when it was introduced at Comdex last spring. Intel claimed the 80486 would perform two to four times faster than the 33-MHz version of the 80386 announced at the same time.

The discrepancy between promise and performance exists because these 486-based PCs are designed to utilize the capabilities of software packages more powerful than DOS. In fact, Intel product managers claim that optimal performance is achieved only when the 486 chip runs in protected mode with unsegmented memory and 32-bit instructions. Engineers at both ALR and Hewlett-Packard agree in principle with this statement but aren't yet ready to proclaim that the 486 will reach Intel's optimistic goals.

The PCs designed around the 486 are clearly aimed at taking advantage of software potential. That becomes obvious when you look inside these machines and find that they can address great amounts of real, physical memory. The ALR PowerCache/4 and the HP Vec-

BENCHMARK TESTS: 25-MHz 486-BASED SYSTEMS

Although these 486-based systems will run DOS applications, PC Labs benchmark tests indicate that they'll only run them about 10 percent faster than a 33-MHz 80386-based PC. Unfortunately, the tests don't really reveal the power of these machines for running OS/2 or Unix, because they show only how quickly the 486 processes 16-bit data using 16-bit instructions. Furthermore, the 486's internal 8K cache appears to handle the test programs and data effectively, neutralizing the impact of ALR's external cache. Since the 486 systems don't employ disk subsystem technology that is radically different from their 33-MHz kin's, disk I/O isn't much better. On the other hand, the ALR PowerCache/4's use of a new video-memory caching chip from Tseng Laboratories yields the fastest video performance since the Compaq Deskpro 386/33.



Performance Times (Times given in seconds)

	80386 Instruction Mix	Conventional Memory	DOS File Access (Small Records)	DOS File Access (Large Records)	Direct to Screen
IBM PS/2 Model 70-A21 (25 MHz)	2.19	0.33	72.34	6.71	6.53
Compaq Deskpro 386/33	1.67	0.25	52.27	3.89	0.99
Hewlett-Packard Vectra/486	1.52	0.27	49.30	3.79	4.50
ALR PowerCache/4	1.48	0.28	56.60	3.57	2.03
ALR PowerCache/4e	1.48	0.27	52.78	3.96	0.99

The 80386 Instruction Mix benchmark test times a series of tasks specific to the 80386 chip. Since this test shows how the CPU operates in the context of the bus, processor, system memory, and motherboard architecture, a faster time means better overall computer performance.

The Conventional Memory benchmark test measures the read/write speed of the first 640K of memory. Slower relative times can indicate the presence of memory wait states or memory chips rated at slower access speeds.

The DOS File Access (Small Records) benchmark test times disk throughput as a result of mechanical disk drive speed, hard disk controller function, and bus speed. The test is performed without software disk caching. Fast times are advantageous for programs that work with many short segments of data.

The DOS File Access (Large Records) benchmark test times disk throughput as a result of mechanical disk drive speed, hard disk controller function, and bus speed. This test

minimizes the effect of small hardware caches on disk subsystem performance. It is performed without software disk caching. Fast times are advantageous when large files are loaded.

The Direct to Screen benchmark test indicates the speed of the video adapter memory. Good scores indicate that information can get to the screen quickly, particularly for programs that avoid the computer's BIOS and go directly to the screen.

486 TURBO CARDS COME FROM SURPRISING SOURCES

CONTINUED FROM PAGE 35
MHz machines. While the upgraded Everex machines have a brand new name—Everex Step 486—AST offers its 486 card, the FASTboard 486/25, as an option for its Premium line of computers. For the AST Premium 386SX, the FASTboard costs \$6,395; for the Premium 386/25, the board costs \$3,695; and for the Premium 386/33, it costs

\$2,995. Both the AST and Everex boards use full 32-bit memory, and the Everex performs most of the PC Labs benchmark tests as well as the ALR and Hewlett-Packard 486 machines tested in our previous article.

Should you buy one of these? If you want a 486 status symbol for your desk, go for it. But if you want a network server, buy the real thing. ■

er, and all the OS/2 applications you might want to run on these machines.

What differentiates the 486-based machines we have reviewed here? In addition to clever memory cache designs, ALR has added its latest write-back design to the 486's internal 8K cache in both of its new machines. The logic for the cache is housed in an ALR-designed ASIC (application-specific integrated circuit) rather than in discrete gate arrays. The PowerCache/4 and PowerCache/4e each have 128K of static RAM in their caches. This means that a pair of the new ASICs must operate on 64K each in interleaved mode.

The engineers at ALR claim that the new ASICs take full advantage of the 486's 128-bit burst mode memory access, in which the processor accesses memory 128 bits at a time (versus the 386's 32-bit memory ac-

cesses). That's difficult to measure with the PC Labs benchmark tests. The programs and data for our benchmark tests appear to be managed effectively by the 486's internal 8K cache, so the impact of ALR's cache is neutralized. Both ALR machines produce similar performance results, which is not surprising since there is nothing in our tests to differentiate bus designs.

One difference does become apparent in video performance. Both the ALR PowerCache/4 and PowerCache/4e machines come with VGA cards installed. Unlike IBM, ALR chose to make its 16-bit VGA card sit in the video slot of the MCA bus rather than embed it permanently in the system board. And all VGA cards are not created equal. The MCA machine's card is powered by Chips and Technologies' 82C452, consid-

CONTINUES ON PAGE 38

First Looks

486 Machines

CONTINUED FROM PAGE 36

cred to be one of the faster VGA chips around. But the EISA machine's card uses a new prototype chip from Tseng Laboratories that includes a memory cache for its video memory. The PC Labs benchmark test results show that this machine yields the fastest video performance since the breathtaking Compaq Deskpro 386/33.

Adhering to the company formula, the ALR PowerCache/4e packs high performance in a small-footprint desktop design; both machines are

also available in tower cabinets, with a base hard disk mounted on a swinging door and enough half-height I/O slots to bring a smile to just about any network manager's face. Both PCs come with a minimum of 2MB of RAM, a floppy disk drive (1.2MB 5.25-inch or 1.44MB 3.5-inch), and the ability to accommodate 150MB to 650MB hard disks.

A small but pleasing touch on the PowerCache/4e is a pair of ISA slots—one 8-bit and one 16-bit—alongside the six EISA slots. Their purpose is to house an expansion card if the card won't work in the new EISA environment. A more important feature is the built-in socket for Weitek's new 81487 math coprocessor.

What distinguishes the HP Vectra/486 EISA machine from ALR's is the former's lack of a cache. Hewlett-Packard's memory design is based on a high-speed burst memory controller that interleaves 80-nano-second RAM four ways, 32 bits at a time. At 25 MHz, according to both Intel and HP engineers, this design will achieve the same performance as a cached design. However, Hewlett-

Packard engineers are now working on a large-scale external cache design for the 33-MHz 486 expected next year, and there's plenty of room on the system board to accommodate it.

Housed in the same cabinet are the 486 processor, bus, and memory controllers, which sit on a system board at the base of the tower. The bus itself runs up the side of the unit and contains eight EISA expansion slots. Hard disk configurations can range from 84MB to a maximum of 670MB, and total storage can be as much as 1.3 gigabytes. The Vectra/486 also includes a newly designed HP ESDI controller containing its own 64K RAM cache for disk operations.

Like the ALR machines, the floor-standing Vectra/486 comes with a minimum of 2MB of RAM, one 5.25-inch 1.2MB floppy disk drive, one parallel and two serial ports, disk-caching software, and memory-management software. You can upgrade the machine's RAM by adding 1MB, 4MB, or 8MB SIMM chips directly to the system board.

The general performance

PC
MAGAZINE

FACT FILE

Hewlett-Packard Vectra/486
Hewlett-Packard Co.,
Customer Information Center,
19310 Pruneridge Ave.,
Cupertino, CA 95014; (800)
752-0900.
List Price: Model 150 with
2MB RAM, 1.2MB 5.25-inch
floppy disk drive, 152MB hard
disk drive, \$13,999; Model 330
with 2MB RAM, 1.2MB 5.25-
inch floppy disk drive, 330MB
hard disk, \$16,999; Model 670
with 2MB RAM, 1.2MB 5.25-
inch floppy disk drive, 670MB
hard disk, \$19,999.
In Short: A 486-based EISA
machine that makes use of a
high-speed burst memory
controller rather than cache
memory. The ESDI disk
controller gives the Hewlett-
Packard Vectra/486 an edge
over the competition.

CIRCLE 434 ON READER SERVICE CARD

level of the HP Vectra/486 is roughly the same as that of the two ALR machines. The PC Labs benchmark tests reveal only what the 486 processor will do while processing 16-bit data using 16-bit instructions and cannot differentiate between bus or memory designs. The Vectra/486's disk controller shows some advantage over the competition, and Hewlett-Packard states that production versions of the new card will be user-adjustable, so that you can optimize performance for your applications. By the time this review appears, Hewlett-Packard should have a new, high-performance VGA card available for the Vectra/486.

If you were expecting the new breed of 486-based PCs to be the next great answer to spreadsheet performance, save your money. Given the fact that the PC Labs benchmark tests clock them at only 10 percent faster than 33-MHz 386-based machines that cost half as much, you're probably better off with a high-performance 386. On the other hand, if you need a file server with the best future potential, or if you simply must have the latest PC technology on your desk, then rush right out and buy one of these 486s. Just don't waste time running DOS applications. ■

PC
MAGAZINE

FACT FILE

Applied Logic Research, 9401
Jeromino, Irvine, CA 92718;
(714) 581-6770.

ALR PowerCache/4
List Price: Model 130
(desktop) with 2MB RAM,
1.44MB 3.5-inch floppy disk
drive, 130MB ESDI hard disk,
VGA adapter, \$9,990; Model
150 (tower) with 2MB RAM,
1.44MB 3.5-inch floppy disk
drive, 150MB ESDI hard disk,
VGA adapter, \$11,490; Model
340H with 2MB RAM, 1.44MB
3.5-inch floppy disk drive,
340MB ESDI hard disk, VGA
adapter, \$14,490; Model 650H
with 2MB RAM, 1.44MB 3.5-
inch floppy disk drive, 650MB
ESDI hard disk, VGA adapter,
\$16,490.

CIRCLE 432 ON READER SERVICE CARD

ALR PowerCache/4e
List Price: Model 150 (tower)
with 2MB RAM, 1.2MB 5.25-
inch floppy disk drive, 150MB
ESDI hard disk, VGA adapter,
\$12,995; Model 340H with 2MB
RAM, 1.2MB 5.25-inch floppy
disk drive, 340MB ESDI hard
disk, VGA adapter, \$15,995;
Model 650H with 2MB RAM,
1.2MB 5.25-inch floppy disk
drive, 650MB ESDI hard disk,
VGA adapter, \$17,995.
In Short: The 486-based
PowerCache/4 (MCA) and
PowerCache/4e (EISA)
support the largest static RAM
cache in the industry. The
PowerCache/4e sports the
fastest video performance
since the Compaq Deskpro
386/33.

CIRCLE 433 ON READER SERVICE CARD

The ALR Power-
Cache/4 supports
the largest static
RAM cache in the
industry.



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OPTIONS:	MONO	EGA	VGA
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30MB 65MLS	1287	1687	1767
40MB 28MLS	1427	1827	1907
80MB 28MLS	1607	2007	2087
120MB 28MLS	1748	2148	2228

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- HDD/FDD Controller 1:1
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- 200 Watt Power Supply
- Norton SI 210
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- System Level Interrupt
- Seven Channel DMA for Disk and Special I/O
- 8 Expansion Slots: 3-32 Bit, 5-MB & 1-8 Bit
- Enhanced 101 Key Keyboard
- PF's First Choice Integrated Software
- IBM® Compatible

OPTIONS:	MONO	EGA	VGA
One Floppy	\$1988	\$2388	\$2468
40MB 28MLS	2407	2807	2887
80MB 28MLS	2587	2987	3067
120MB 28MLS	2728	3128	3208



Ultra-Max 386-25 \$2469

- 10/25 MHz Motherboard
- 1MB 80NS RAM
- 80386-25MHz Intel Double Sigma CPU
- 80387 Co-Processor Socket
- 287 Math Co-Processor Socket
- Choice of 5.25" 1.2MB or 3.5" 1.44MB Floppy Drive
- HDD/FDD Controller 1:1
- 200 Watt Power Supply
- 64K DR. Mapped 256K SRAM Cache Memory
- Write Back Cache Design
- Norton SI 310
- Landmark Speed Test 43.5MHz V399
- MIPS 514.2
- 1 Parallel and 2 Serial Ports
- System Level Interrupt
- Seven Channel DMA for Disk and Special I/O
- 8 Expansion Slots: 1-32 Bit, 4-MB & 1-8 Bit
- On Board Battery Backup
- Enhanced 101 Key Keyboard
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- IBM® Compatible

OPTIONS:	MONO	EGA	VGA
One Floppy	\$2598	\$2998	\$3078
40MB 28MLS	3027	3427	3507
80MB 28MLS	3227	3627	3707
120MB 28MLS	3338	3738	3818



Ultra-Max 386-33 \$3469

- 8/33MHz Motherboard
- 1MB 32 Bit 80NS RAM
- 80386-33MHz Intel Double Sigma CPU
- 80387 Co-Processor Socket
- 287 Math Co-Processor Socket
- Choice of 5.25" 1.2MB or 3.5" 1.44MB Floppy Drive
- HDD/FDD Controller 1:1
- 200 Watt Power Supply
- 32K 10NS Static RAM Cache
- Direct Memory 2-Way Associative Cache
- Norton SI 401
- Landmark Speed Test 58.7MHz
- MIPS 17796
- Phoenix BIOS
- 8 Expansion Slots: 1-32 Bit, 5-MB & 2-8 Bit
- 1 Parallel and 2 Serial Ports
- Relocatable Video & System BIOS to RAM
- EMS Memory Manager
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80MB 28MLS	4327	4727	4807
120MB 28MLS	4438	4838	4918

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OS/2 1.2 Offers New File System, Enhanced Shell

HANDS ON
by Charles Petzold

While users wait for more applications before considering OS/2, IBM and Microsoft continue adding enhancements to the operating system. OS/2 1.2 (released by IBM in September and expected from other manufacturers in the next three to six months) has a new file system, a new Presentation Manager shell, new PM utility programs, and even a 3-D facelift.

The big news is the High Performance File System (HPFS), which is designed for fast and efficient storage on large disk volumes. HPFS supports long free-form filenames and lays the foundation for an Object Oriented File System (OOFS) expected in a forthcoming release of OS/2.

HPFS is intended as a replacement for the FAT (File Allocation Table) file system origi-

nales greater than 32MB. Moreover, FAT filenames are limited, allowing only an eight-character name and a three-character extension.

HPFS supports disk volumes up to 2 terabytes (2 trillion bytes) and files up to 2 gigabytes (2 billion bytes). HPFS filenames may be 254 characters long (with the limitation that the combined directory path and filename, excluding the first backslash, is limited to 256 characters). The filenames may contain any number of periods and even spaces. HPFS also supports extended attributes, which are text or binary data attached to a file using keywords similar to environment strings. This facility is expected to be important in a future Object Oriented File System layer on top of HPFS. In addition, HPFS is more space-efficient than FAT in storing small files, faster in finding free disk space, and

OS/2 and DOS machines. Existing OS/2 programs (and DOS programs that are run in the OS/2 DOS Compatibility Mode) can use files on an HPFS drive, but only if the filenames follow the old FAT convention. New OS/2 programs can use larger filenames. No version of DOS can recognize or use an HPFS partition.

HPFS takes full advantage of the new Installable File System (IFS) facility in OS/2. OS/2 1.2 can effectively support various file systems through loadable files that are similar in concept to device drivers. In the future, OS/2 installable file systems may also include support for CD-ROM or the Unix file system.

OS/2 1.2 also includes a revamped Presentation Manager shell that makes greater use of icons and allows more direct manipulation of objects. While the new Presentation Manager shell is certainly an improvement over the OS/2 1.1 shell, it is still not ideal. Printer configuration has been moved from the Control Panel to the Print Manager, but it hasn't been simplified very much.

Several new Presentation Manager utility programs are included in OS/2 1.2: a text editor; a PM version of FDISK; three programs for converting, displaying, and printing PM graphics metaphors; and an on-line reference for all of the OS/2 command-line programs. The detailed reference for these com-

mands has been removed from the OS/2 instruction manuals.

OS/2 1.2 also supports a dual-boot option to allow either OS/2 or DOS to be booted from the hard disk. This is the first time IBM has included dual boot in OS/2. Dual boot is automatically added during the installation of OS/2 if the first hard disk partition contains a ver-



FACT FILE

IBM OS/2 Standard Edition 1.2

Contact your authorized IBM dealer.
List Price: \$340; upgrade from DOS 3.x or 4.0, \$265; upgrade from OS/2 1.0 or 1.1, \$100.
Requires: IBM PC AT, PC-XT Model 286, or PS/2 with 286 or 386 microprocessor; 2MB memory; graphics video adapter and display.
In Short: OS/2 1.2 has a new file system, a revamped Presentation Manager shell, and a new 3-D look. The file system seems hot, the 3-D effect is pleasant, but the shell—as usual—needs work.

CIRCLE 481 ON READER SERVICE CARD

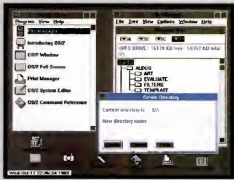
sion of DOS and you don't reformat the partition. However, improvements in the DOS Compatibility Mode make booting DOS less necessary. DOS Compatibility Mode gives DOS programs over 512K memory out of 640K. Some earlier problems (such as the inability to use a mouse in DOS graphics programs that use VGA) have fortunately been corrected.

OS/2 1.2 contains graphics printer drivers for all IBM printers, all IBM and Hewlett-Packard plotters, Epson 9- and 24-pin dot matrix printers, and 33 different PostScript printers and typesetters. The only glaring omission (which should be remedied by the time you read this) is a missing driver for the Hewlett-Packard LaserJet series.

The Presentation Manager has also received a facelift of sorts. The push buttons, scroll bars, and icons now have a 3-D or "chiseled" design similar to that in OS/Motif (the Unix PM-look-alike) and the NeXT machine. Existing PM programs will use these restyled buttons and scroll bars automatically when running under OS/2 1.2.

The next version of the operating system is expected to be OS/2 2.0, and is due to be released sometime in 1990. OS/2 2.0 will use the 386 microprocessor to give applications access to a flat 32-bit (4-gigabyte) address space and to multitask multiple DOS sessions.

The window on the left is used to launch programs in IBM OS/2 Standard Edition 1.2. The window on the right is the OS/2 File Manager program. A File Manager dialog box (lower right) shows the new 3-D push buttons.



inally designed by Bill Gates for Microsoft Disk BASIC way back in 1977. The FAT file system has been supported in all versions of DOS and OS/2. While it's fine for floppy disks, FAT has never been quite adequate for hard disks. For a long time, the FAT system could not accommodate hard disk vol-

umes much less inclined to fragment large files.

OS/2 1.2 continues to support the FAT file system, of course. You can format hard disk partitions for either HPFS or FAT. Floppy disks are always formatted with the FAT file system and thus may still be used to transfer files among

First Looks

Excel for OS/2 Adds New Consolidation Feature, Improves Font Handling

HANDS ON
by Craig Stinson

The Presentation Manager version of *Excel*, *Microsoft Excel for OS/2*, is basically the same gorgeously graphical spreadsheet that 10 to 15 percent of the market already knows and admires. But *Excel for OS/2* offers significantly broader font-handling capabilities, a new command, and a handful of improvements bestowed upon it by OS/2.

The new command, *Data Consolidate*, is designed to simplify the consolidation of data from source worksheets that are not identical. To use the command, select a destination area on the consolidation worksheet, point to each source range in the dialog box that you want to consolidate, select the function you want *Excel* to perform, and hit the OK button. *Excel* will consolidate cells in the corresponding positions of each source range, depositing the result (as a constant) in the destination range.

When positional consolidation is not necessary, you can consolidate only those cells that share common headings. Thus, if some of your source worksheets have the months arranged in consecutive columns, while others are broken up by averages or quarterly totals, you can use the *Top Row checkbox* (or the *Left Column checkbox*, or both) to avoid the misery of restructuring your worksheets.

Data Consolidate is a welcome enhancement, but it has one serious shortcoming. Because it generates constants on the destination worksheet instead of file-linking formulas, it's effective only when used after all source data is in place. And it leaves no built-in audit trail; users will have to create cell notes or some other form of documentation to indicate the

source of the numbers. A file-linking variant of *Data Consolidate* would be a more persuasive counter to the three-dimensional capabilities of *Lotus 1-2-3*, Release 3.0.

In the font department, *Excel for OS/2* allows you to mix a maximum of 256 fonts on a given worksheet; in the *Windows* version, you get only four. You can pick from the font repertoire of your current printer or from the set of screen fonts installed on your system.

Two major improvements are results of OS/2. With *Excel for OS/2*, you'll avoid the irritating slowdowns that are commonplace under *Windows*. The absence of a 640K barrier and the presence of disk-based virtual memory take the fear out of building gigantic worksheets or opening a multitude of ordinary ones. Between them, the *Win-*

dows and PM versions of *Excel* come with more than 40 sample worksheets, charts, and macro sheets; I loaded them all into the PM version without straining the system in any apparent way.

The High Performance File System (HPFS), optional in OS/2 1.2, lets you create descriptive filenames and gives you improved I/O performance. Even without HPFS (I used the standard FAT system for this review), *Excel for OS/2* turned in better file-saving and file-loading times than the *Windows* version. (On memory-bound benchmarks, the two versions performed identically.)

Should you move from the *Windows* version of *Excel* to the PM version? Sure, if you need immediate relief from the memory constraints of *Windows 2.0*. But with DOS extenders becoming common for use with big applications, it's not unreasonable to speculate that Microsoft may address your capacity concerns adequately with the next version of *Windows*. You might want to wait and see.

If you're still deciding on the right spreadsheet or considering a switch, and if interoperability is a concern, the arrival of



FACT FILE

Microsoft Excel for OS/2
Microsoft Corp., 16011 NE 36th Way, Redmond, WA 98073;
(206) 882-8080
List Price: \$495; upgrade from Microsoft *Windows* version, \$50.

Requires: 2.5MB RAM, OS/2 1.2 or later.

In Short: The PM version of Microsoft *Excel* lets you mix 256 fonts on a worksheet and includes a new command for consolidating disparate worksheets. The OS/2 environment adds better aesthetics, freedom from the 640K barrier, disk-based virtual memory, faster disk I/O, and (in OS/2 1.2 or later) the option of creating descriptive filenames.

CIRCLE 444 ON READER SERVICE CARD

Microsoft Excel for OS/2 may give you another reason to consider going with Microsoft's new program. As of this writing, *Excel* is the only strong spreadsheet with identical and completely file-compatible versions for the Macintosh, DOS, and OS/2. The odds are in favor of it staying that way for a while.



PERFORMANCE TESTS: MICROSOFT EXCEL FOR OS/2

Although the OS/2 implementation of Microsoft *Excel* recalculates at about the same speed as its Microsoft *Windows*-based analog (running under Microsoft *Windows 386*), the OS/2 version performs disk-intensive operations 40 to 50 percent faster.

Mathematical Worksheet Recalculation reports the time taken to calculate a *Lotus 1-2-3 2.01* worksheet with 1,950 mathematical functions and 494 text cells. Lower times indicate more efficient implementation of standard spreadsheet functions.

The **Loan Recalculation** test worksheet calculates the monthly payment and displays the amortization schedule for a 10-year mortgage based on any given loan principal. This test is a typical spreadsheet application.

Internal Rate of Return Recalculation tests the Net Present Value and Internal Rate of Return functions. These computation-intensive formulas indicate the efficiency of a program's calculation and internal rate of return algorithms.

The **Save to Disk** test measures how long it takes the spreadsheet program to

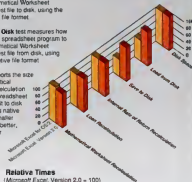
save the Mathematical Worksheet Recalculation test file to disk, using the product's native file format.

The **Load from Disk** test measures how long it takes the spreadsheet program to read the Mathematical Worksheet Recalculation test file from disk, using the product's native file format.

Disk Space reports the size of the Mathematical Worksheet Recalculation file when the spreadsheet program saves it to disk in the program's native file format. A smaller number here is better, leaving room for more or bigger files on the same disk.

Relative Times
(Microsoft *Excel*, Version 2.0 = 100)

Performance Times (Times given in seconds, disk space given in kilobytes)	Mathematical Worksheet Recalculation	Loan Recalculation	Internal Rate of Return Recalculation	Save to Disk	Load from Disk	Disk Space
Microsoft <i>Excel</i> for OS/2	22.53	1.51	1.50	3.53	12.59	78.76
Microsoft <i>Excel</i> , Version 2.0	21.30	1.35	1.61	7.04	20.62	78.75



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60MB/25MS RL	\$635	\$815	\$1,075	\$1,250
71MB/25MS RL	\$810	\$990	\$1,250	\$1,425
120MB/25MS RL	\$660	\$1,040	\$1,300	\$1,475

	MONO 720x348	VGA MONO 640x480	16 BIT VGA COLOR 640x480	16 BIT SUPER VGA 800x600
100MB/20MS ESD	\$1,280	\$1,460	\$1,720	\$1,865
200MB/20MS RL	\$1,850	\$2,030	\$2,290	\$2,465
300MB/20MS ESD/SCSI	\$2,250	\$2,430	\$2,690	\$2,865

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186 CONFIGURATION CHART

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	MONO 720x348	VGA MONO 640x480	VGA COLOR 640x480
20MB/16MS	\$385	\$565	\$850
40MB/20MS	\$525	\$700	\$990

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First Looks

The Complete Communicator: Fax, Modem, Voice Mail, and Scanner on One Board

HANDS ON
by Edward Mendelson

The Complete Communicator lets you do almost everything you could imagine doing with a telephone, including calling up the local pizzeria with a take-out order and getting a confirmation in return.

If you happen to own the pizzeria, you can use The Complete PC's \$899 slot-saving communications board in three different ways: as a 9,600-bit-per-second fax board to send or receive copies of your menu, as a voice mail system to accept telephone orders, and as a 2,400-bps modem to upload orders for sauce and cheese to your suppliers.

If you have The Complete Hand Scanner or Page Scanner, you can plug it directly into The Complete Communicator and use it to scan your menu for faxing, graphics editing, or OCR. The board also works with Microtek Lab, Hewlett-Packard, DEST Corp., and Canon USA scanners, although these need their own boards.

The Complete Communicator (or C-Comm) manages to squeeze all these functions onto a three-quarter-length XT-size board with two small daughterboards. The whole system fits into a single slot. The board's software offers a clear, integrated, menu-driven communications system for faxing, voice mail, and scanning, and its extensive command-line options let you create batch files to automate anything you can do from the menu.

The fax and voice mail functions can run in the background, and you can transfer binary files at 9,600 bps to another C-Comm or a Complete PC fax board. For ordinary foreground communications, you can use the BitCom program that comes in the package or substitute the communications program of

The Complete Communicator combines voice mail functions with a 9,600-bit-per-second fax and a 2,400-bps modem.

your choice. The program you choose appears on the main menu.

The C-Comm voice mail functions listed in the manual's diagrams may look hair-curlingly complicated, but the software makes them almost intuitive, and the context-sensitive help is refreshingly detailed. The board lets you set up multiple mailboxes with customized greetings, and once it's set up, you can call in from a remote telephone to listen to your messages, forward them, or even reconfigure the system.

The software comes with a recording of an anonymous female voice that greets your callers and instructs them to press * (star) to listen to their recording, 6 to delete it, 8 to replay the last 8 seconds, and onward through five more dizzying choices that can include transferring to a separate mailbox. Fortunately, callers can leave a message simply by speaking and hanging up. You can greet callers with your own voice if you don't like the anonymous one.

Your recorded outgoing calls can be sent to one or more numbers at any specified time. You can ask a recipient to record a return message, a function that opens the possibility of conducting elaborate conversations without ever being on the phone at the same time as the

person you're talking to. Expect to use up to 3.5K of disk space for every second of recorded greetings and messages. Unless you archive messages for later use, each mailbox fills a reasonable 1- to 2MB.

The fax functions are essentially the same as those of The Complete Fax/9600, a board that was enthusiastically reviewed in the April 11, 1989, issue of *PC Magazine* ("PC to Paper: Fax Grows Up"). You can send faxes directly from any application by popping up a TSR screen and telling the application to print to an Epson FX printer. A TSR captures text and graphics on the way to the printer and converts them to fax format, using a boxy but legible font.

Thankfully, you can configure any arcane combination of hotkeys for the TSR to avoid conflicts with other applications. Another feature lets you forward faxes when you call from a remote telephone to your voice mailbox.

The fax-viewing function, unlike those that come with many fax boards, uses a menu structure similar to that of the rest of the software. You can zoom, flip, or rotate any viewed faxes. You can print to any standard printer, including PostScript models. A conversion menu lets you turn .PCX,


Dr. Halo, and Windows Paint files into fax format and back again, and you can also convert faxes to TIFF files. Unlike earlier versions, The Complete PC's fax software now lets you print speedily in the foreground as well as slowly in the background.

Impressive as it is, C-Comm has some minor and easily correctable flaws. The resident software eats up 97K of RAM, and background printing requires another 110K. Intel Corp.'s Connection CoProcessor fax board tucks most of its software away into expanded memory, and there's no good reason why The Complete PC can't do the same.

In addition, the three-quarter-length board lacks a speaker, which would let you monitor outgoing calls without picking up the phone. The manual suggests that you buy an external battery-powered speaker and plug it into a connector on the board's bracket.

Without its two daughterboards, C-Comm is identical to the \$699 Complete Fax/9600. If you own that board, you can upgrade it to a C-Comm by adding a \$99 modem daughterboard and a \$199 voice mail daughterboard.

Whether you build it by upgrading or buy it complete, The Complete Communicator is the most versatile and impressive communications board on the market.

**FACT FILE**

The Complete Communicator
The Complete PC, 521
Cottonwood Dr., Milpitas, CA
95035; (408) 434-1045.
List Price: \$899.
Requires: 640K RAM, 4MB on
hard disk, DOS 3.1 or later,
graphics adapter needed for
fax viewing.
In Short: A single expansion
board that combines numerous
voice mail functions with a
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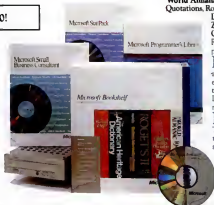
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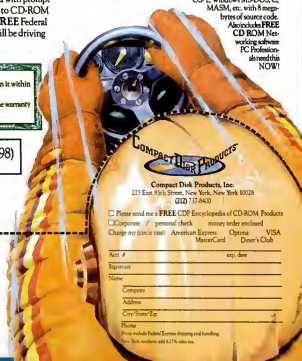
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First Looks

Cumulus 386SX Puts 386 Power into Old ATs

HANDS ON
by Winn Rosch

When it was first introduced, Intel Corp.'s 80386SX proved the greatest tease since the first Hollywood cliff-hanger. Could this unassuming little sliver of black epoxy save all the ATs in the world from certain obsolescence? Could it give CPR to brain-dead 286 computers?

The quick answer was a heartbreaker: the 386SX was not pin-compatible with the 286. For a year we've lived with promises of adapter boards that would put the 386SX in ATs. Finally, the first has arrived, the \$595 Cumulus 386SX card.

Plug it in and your old AT or 286-based PS/2 (Model 30/286, 50, 55, or 60) moves to the head of its class. The card will allow your machine to understand 32-bit 386 instructions, open up a new world of software, add advanced memory management, and fully implement the 386's

virtual 8086 mode. That means multitasking with 386 operating environments, moving TSR programs to high memory, and running the latest versions of 386-only programs.

The Cumulus 386SX card is a 2.5-inch-square board that hosts two sides full of surface-mount chips (including the Intel 386SX microprocessor) and a socket waiting for a 387SX numeric coprocessor. Available to fit both Pin Grid Array sockets in IBM machines and Plastic Leadless Chip Carrier sockets in Compaqs and other compatibles, it plugs easily into place.

You won't spend more than 10 minutes setting up the Cumulus card. The company includes an automated program to install the board's driver software for DOS and OS/2 as well as a memory management driver.

The chip on the Cumulus 386SX card can run at either twice the speed of the host computer or at its normal operating


speed, as long as the chip's operating frequency does not exceed its 16-MHz rating.

Don't expect a tremendous performance increase, however. While standard 8-MHz ATs will show slightly increased performance results because the microprocessor marches double-time, faster machines will force the 386SX to run at their standard pace. Unlike 386-based turbo boards, the Cumulus 386SX has only minor effects on disk and video performance. Overall, expect the feel of your system and its performance to be unchanged after installing the Cumulus 386SX.

But drop in a 387SX to replace the native 287 and the situation changes. The 387SX, a more efficient design, runs about five times faster than its 287 predecessor.

Adding the 387SX complicates the simple plug-in installation, because a \$100 cable must be run from the 287 socket to the 387SX board. This cable is required to accommodate 387 signals not used by the 287.

Performance is not the primary reason for buying the 386SX. Memory management is. Once the 386SX card is in



PC
MAGAZINE

FACT FILE

Cumulus 386SX
 Cumulus Corp., 23500
 Mercantile Rd., Beechwood,
 OH 44122; (216) 464-2211.
 List Price: \$595.
Requires: IBM AT; IBM PS/2
 Model 30/286, 50, 55, or 60; or
 Compaq Deskpro 286.
In Short: A small circuit board
 that replaces an 80286
 microprocessor with an
 80386SX to add the memory
 management, 32-bit instruction
 handling, and virtual 8086
 mode of the 80386
 microprocessor to 16-bit
 computers.

CIRCLE 447 ON READER SERVICE CARD

your AT, you can use all the clever software written for 386s, including Qualitas's *386-to-the-Max* and Quarterdeck Office Systems' *QEMM*. However, the Cumulus memory management driver duplicates so many of the functions of these utilities that you might not need them.

The 386SX ran all the 386-specific programs we tried and did not interfere with OS/2's operation on the Model 60. It's also compatible with Unix (except Xenix 286 on Compaq platforms). As with all 386 memory managers, the Cumulus memory driver had to be defeated to run *Windows/386*.

The one nagging problem with the 386SX card is shared by any plug-in microprocessor replacement board—that the assembly is somewhat taller than the chip it replaces and may interfere with expansion boards in slots that extend over the chip socket. By itself, it stood tall enough to block one slot in the Model 60. Add the 387SX extension and it may block three. Because of their differing microprocessor placements, however, ATs and Compaqs don't suffer from this problem.

For all its complexity, the 386SX card is essentially invisible once installed. And that's its greatest asset. If you want to run tomorrow's software on yesterday's computer, get a Cumulus 386SX.



BENCHMARK TESTS: CUMULUS 386SX

Slow ATs will experience a slight performance increase because of the 386SX chip's 16-MHz clock speed, but since memory and bus speed remain unchanged, throughput won't double. Faster machines will force the 386SX to run at their standard pace. Unlike 386-based accelerator cards, the Cumulus 386SX card has only minor effects on disk and video performance.

The **80386 Instruction Mix** benchmark test times a series of tasks specific to the 80386 chip. Since this test shows how the CPU operates in the context of the bus, processor, system memory, and motherboard architecture, a faster time means better overall computer performance.

The **Conventional Memory** benchmark test measures the read/write speed of the first 64K of memory. Slower relative times can indicate the presence of memory wait states or memory chips rated at slower access speeds.

The **DOS File Access (Small Records)** benchmark test times disk throughput as a result of mechanical disk drive speed, hard

Relative Times
(Compaq Deskpro
386S = 100)

disk controller function, and bus speed. The test is performed without software disk caching. Fast times are advantageous for programs that work with many short segments of data.

The **DOS File Access (Large Records)** benchmark test times disk throughput as

a result of mechanical disk drive speed, hard disk controller function, and bus speed. This test minimizes the effect of small hardware caches on disk subsystem performance. It is performed without software disk caching. Fast times are advantageous when large files are loaded.

Performance Times
(Times given in seconds)

	80386 Instruction Mix	Conventional Memory	DOS File Access (Small Records)	DOS File Access (Large Records)
IBM PC AT (8 MHz) with Cumulus 386SX	8.01	1.35	72.77	18.95
Compaq Deskpro 386S	4.48	0.63	64.04	7.31
IBM PC AT (8 MHz)	N/A	1.40	72.66	18.90

N/A—Not applicable

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Photographs: Harry Langdon

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OS/2™ FEATURES

CIRCLE 106 ON READER SERVICE CARD

First Looks

SpeedKit Cache Controller for ATs: Tricky Installation, Faster File Access

HANDS ON
by Edward Mendelson

Western Digital Corp.'s \$225 SpeedKit, a hard disk controller replacement, lets anyone who owns an ordinary AT and a standard ST-506/MFM hard disk join the speed-is-what-matters school of computer design. The SpeedKit comes with a small hardware cache that holds 13 sectors of data and lets the controller handle the high transfer rate needed to support a 1:1 disk interleave.

With a 1:1 interleave, the controller can read all the data on a track in a single rotation. The standard AT controller can handle only a less efficient 3:1 interleave. In the PC Labs benchmark tests, the SpeedKit read data twice as fast as the standard AT model, although that speed level will only occur with highly disk-intensive applications.

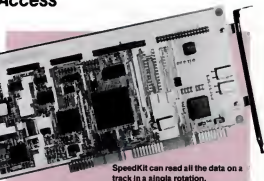
You can pull out your standard AT controller, drop in the SpeedKit, and hook up your floppy disk drives and two hard disks, but you won't get any noticeable benefits until you change the hard disks' interleave to 1:1. This is when the trouble begins. If you have a utility that can reset the interleave of an MFM disk without forcing you to back up and restore your files, you can proceed without hindrance.

If you don't have such a program, you need to use a destructive low-level format program. Even if you received one with your computer, it may not support a 1:1 interleave, and you'll have to use the program that comes with the SpeedKit package. It isn't a program for the fainthearted.

First, all files on your disk will be destroyed and will have to be restored from your backups after you run FDISK and DOS's FORMAT. Second, Western Digital seems to have

gone out of its way to make the job difficult. The controller, which has no BIOS, isn't smart enough to read the disk manufacturer's table of bad sectors, so you have to type in the list—very carefully. Unless you have a standard 20MB IBM hard disk, you have to type in the correct number of cylinders, heads, and sectors per track and the precompensation value for your disk.

What? You don't know your disk's precompensation value? Western Digital's manual doesn't provide the value for any standard IBM-supported drives; it suggests that you consult your computer manual or dealer. If necessary, the figures you need for IBM and Compaq



SpeedKit can read all the data on a track in a single rotation.

drives can be found in the manual that comes with *The Norton Utilities—Advanced Edition*, Version 4.5.

If all this leaves you feeling dizzy, you may decide that speed isn't all that matters. ■

List Price: SpeedKit, \$225.
Requires: Standard AT-type ST-506/MFM hard disk. Western Digital Corp., 2445 McCabe Way, Irvine, CA 92714; (714) 474-2033.

CIRCLE 488 ON READER SERVICE CARD

Invisible RAM Manages Shadow RAM for 286- and 386-based PCs

HANDS ON
by Ray Duncan

For \$39.95, Invisible Software's *Invisible RAM* provides the same memory management capabilities as the vendor's *Invisible Network* without all the required software and hardware. The program increases the amount of memory available for DOS applications, TSRs, and device drivers by utilizing the shadow RAM that is available on certain types of motherboards.

Ordinarily, shadow RAM is mapped at the same addresses as the ROM BIOS; during system initialization, the machine code of the ROM BIOS is copied from (relatively slow) ROM to (relatively fast) RAM so that it will execute more quickly. *Invisible RAM* recovers the shadow RAM and maps it at addresses

that don't overlap the ROM BIOS's modules, allowing it to be used for the execution of other programs.

Invisible RAM is simple to install and use. The first step is to install SHADOW.SYS, a special device driver that manages the shadow RAM, using a DEVICE= statement in the CONFIG.SYS file. When it is loaded, SHADOW.SYS takes control of the shadow RAM from the ROM BIOS and front-fills the conventional memory area up to the base of the first video refresh buffer—leaving a maximum of 736K available for DOS applications.

Two other *Invisible RAM* utilities, LSHADOW.SYS and LSHADOW.COM, can then be used to load other device drivers and TSRs into the remaining shadow RAM, using additional commands in the CON-

FIG.SYS and AUTOEXEC.BAT files.

Invisible RAM is undisputedly a niche product. It works only on PCs based on the Chips and Technologies NEAT or AT/386 chip set, and you must trade the performance improvements ordinarily gained by shadowing the ROM BIOS for the advantages of having more RAM available for your applications.

Invisible RAM is a simple, economical, well-documented product that allows you to unveil some of your PC's hidden resources, and it provides some of the same capabilities found in more-expensive memory managers, such as the All Chess Corp., QEMM-386, or 386-i-the-Max. ■

List Price: *Invisible RAM*, \$39.95. **Requires:** 80286- or 80386-based PC, Chips and Technologies NEAT or AT/386 chip set, 1MB RAM. Invisible Software Inc., 1165 Chess Dr., Suite D, Foster City, CA 94404; (415) 570-5967.

CIRCLE 489 ON READER SERVICE CARD

Sometimes, you just can't copy an original.

With over 500,000 installations worldwide, Carbon Copy Plus™ is the leader in remote PC communications software. In fact, Carbon Copy Plus is used by twice as many people as any other remote software.

Why? Because Carbon Copy Plus is ideal for remote support, troubleshooting and training. With it, you can fix software problems over standard telephone lines from any remote location. The result is substantial savings in travel time and expense.

Carbon Copy Plus lets you access and control a remote PC to train a user or



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Its unique universal graphics translator converts incompatible graphics formats. Original CGA and VGA graphics images can now be replicated as EGA and Hercules images. What an original idea!

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CIRCLE 731 ON READER SERVICE CARD

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by
Alan Cohen

New & Improved

News of Announced Products and Upgrades

Lightweight Laptops Sport Backlit LCD Screens



Both the Toshiba T1000SE and the TI TravelMate LT286 Model 12 weigh under 7 pounds.

NEW

Weighing in at 5.9 pounds, the Toshiba T1000SE shares some features with its lightweight namesake, the T1000, such as an 80C86 processor and a battery-backed RAM disk. The \$1,699 T1000SE, from Toshiba American Information Systems, will be

available at the beginning of 1990. It sports a CGA-compatible backlit LCD screen that displays up to 25 lines of 80 characters or 640-by-400 bitmapped graphics, runs at 9.54 MHz, and incorporates a 1.44MB floppy disk drive. The standard 1MB of RAM can be expanded to 3MB by adding a 1MB or 2MB memory card (\$699 and \$1,199, respective-

ly). The removable battery pack has a claimed life of 2.5 hours and a recharge time of 4 hours. DOS 3.3 is in ROM, and an AutoResume feature allows the user to replace the battery without having to leave the software application first.

Higher up on the price/power scale, Texas Instruments' 6.7-pound TravelMate LT286 Model 12 is one of the first products to offer a 12-MHz 80C286 chip and a 20MB hard disk drive running in a notebook-sized laptop. At \$4,599, the LT286 Model 12 boasts 1MB of RAM and a CGA-compatible backlit super-twisted LCD screen. Applications are loaded off ROM cards. The machine also includes DOS 3.3 and *LapLink Plus* in ROM. System memory can be expanded to up to 4MB, and a snap-on 1.44MB 3.5-inch floppy disk drive is available for \$299. A "sleep" mode powers down the hard disk when the unit is idle.

List Price: Toshiba T1000SE, \$1,699.

Toshiba America Information Systems Inc., Computer Systems Division, 9740 Irvine Blvd., Irvine, CA 92718; (714) 583-3000.

CIRCLE 448 ON READER SERVICE CARD

List Price: Texas Instruments TravelMate LT286 Model 12, \$4,599. Texas Instruments Inc., Information Technology Group, P.O. Box 202230, ITG-001, Austin, TX 78720; (800) 527-3500.

CIRCLE 457 ON READER SERVICE CARD

Cyrix Math Processor Boasts Ten Times the Speed of 80387

NEW

The FasMath 83D87, a CMOS math co-processor from Cyrix Corp., implements its floating-point primitive operations in hardware rather than in a microprogrammed sequencer, resulting in a claimed tenfold increase in performance over the Intel 80387. Fully software and pin compatible with Intel's 80387 chip, the unit performs 5.5 MFLOP, according to the company, and is available in 20-MHz (\$745), 25-MHz (\$925), and 33-MHz (\$1,200) models.

Each version of the processor utilizes a

CONTINUES ON PAGE 54

HOT PROSPECT

IN FOCUS SYSTEMS' PROJECTION PANEL SHOWS TRUE COLORS

While laptop manufacturers race to perfect color LCD displays, In Focus Systems has already incorporated such technology into its latest projection panel, the 480C PC Viewer.

Capable of projecting a total of eight colors—black, white, cyan, magenta, green, yellow, red, and blue—in VGA resolution, the panel allows real-time presentations developed on IBM PCs and Apple Macintoshes to be projected onto a wall or screen with an overhead projector.

The panel utilizes neither the thin film transistor (TFT) nor the double super-twisted nematic (DSTN) LCD technologies currently popular with developers, opting instead for a proprietary, CMYK subtractive system manufactured jointly by In Focus and Kyocera of Japan. The \$4,495 unit features a built-in temperature compensation system and a multispeed fan to eliminate contrast loss and optimize response time. A rotating palette enables users to manipulate the color display and to select color mapping.

List Price: 480C PC Viewer, \$4,495. In Focus Systems, 7649 SW Mohawk St., Tualatin, OR 97062; (800) 327-7231, (503) 692-4968.

CIRCLE 436 ON READER SERVICE CARD

New & Improved

Cyrix Math Processor

CONTINUED FROM PAGE 53

full extended, double-precision, IEEE-754-1985 architecture using an 80-bit internal format for storage and computation. All 117 floating-point instructions of the Intel 80387 are implemented, and computations are performed to 91-bit internal accuracy.

The FasMath chip contains eight data registers, which are accessed in a stacklike manner. A control register and a status register are also provided.

Packaged in a ceramic 68-pin package, the processor dissipates 35 milliwatts of power and runs in an automatic idle mode when not executing floating-point instructions.



Cyrix's FasMath 83D87 processor offers an alternative to the Intel 80387.

List Price: FasMath 83D87-20 (20 MHz), \$745; FasMath 83D87-25 (25 MHz), \$925; FasMath 83D87-33 (33 MHz), \$1,200. Quantity discounts are also available. Cyrix Corp., P.O. Box 850118, Richardson, TX 75085; (214) 234-8387.

CIRCLE 448 ON READER SERVICE CARD

IMPROVED

EzPATH Module for Systat/Sygraph—A structural modeling program designed for use with the MS-DOS version of Systat/Sygraph, EzPATH incorporates a range of methods and models (including multivariate/multimethod models, component analysis, simultaneous equation models, confirmatory factor analysis, and latent variable models) and has an inferential statistical basis for evaluating model fit. Model variables do not have to be classified into types, and the path diagram does not have to be translated into a set of linear equations. Changes to models may be made without exiting the program, which means that EzPATH output can be modified and then fed back into the program as input. EzPATH retails for \$150 and requires 640K RAM. Systat Inc., Evanston, Ill.; (312) 864-5670.

Headroom, Version 2.0—Version 2.0 of Helix Software Co.'s memory manager and application-control package now boasts a simplified, menu-driven installation routine, as well as a fully functioning cut-and-paste option that works between any two applications or TSRs or combinations thereof. In addition, device drivers that take up less than 64K can be swapped to expanded memory. On-board fax programs, which normally sit in RAM and wait for incoming calls, can also be swapped to expanded or extended memory, or to a hard disk, and wait there instead. When a call comes in, Headroom automatically swaps the fax program back into RAM by swapping out the present application. Headroom, Version 2.0, retails for \$129.95. Current registered owners can obtain the upgrade for \$30. Headroom Network Extensions, which provides support for swapping LAN-based products, is available for \$54.95. Helix Software Co. Inc., Briarwood, N.Y.; (800) 451-0551.

Andrew Tobias' Checkwrite Plus, Version 1.1—The latest version of MECA Ventures' budget and checkbook management program includes the CheckFree electronic payment system, which allows users to pay their bills on-line. Checkwrite Plus automatically dials the CheckFree Processing Center and transmits all pertinent payment information. To receive an identification number that will allow access to the service, Checkwrite Plus users must register through CheckFree Corp., whose monthly service charge is \$9.00. Andrew Tobias' Checkwrite Plus, Version 1.1, retails for \$49.95;

CONTINUES ON PAGE 56



Incorporating CheckFree, Andrew Tobias' Checkwrite Plus, Version 1.1, enables users to pay their bills electronically.

Micrografx XPort Converts Graphics Across Formats

NEW

Micrografx XPort helps alleviate the problems of swapping graphics files among applications by giving users the means to convert between most major formats, including those that are object-oriented.

The \$395 package, which runs under Microsoft Windows, supports .CGM, .GEM, .DXF, .DRW, and Macintosh PICT1 and PICT2 files. According to Micrografx, add-on modules for IGES, GDDM, TIFF, and .PCX files will be added in early 1990.

Micrografx XPort also includes a "batch" utility that allows users to select a variety of incompatible files and process them as a group. A translation log records any errors encountered during the conversions.

List Price: Micrografx XPort, \$395. **Requires:** DOS 3.0 or later, Microsoft Windows (runtime version included), Micrografx Inc., 1303 E. Arapaho Rd., Richardson, TX 75081; (800) 272-3729, (214) 234-1789.

CIRCLE 449 ON READER SERVICE CARD

Slidemaker Supports DOS, Windows, Mac

NEW

FilmPrinter Plus, Mirus Corp.'s desktop digital slide-making system, runs on both Macintoshes and DOS-based PCs. The unit employs digital technology for the data interface, dot positioning, and dot recording, effectively eliminating all analog phases of the recording cycle, according to the company.

FilmPrinter Plus requires a software driver specific to the host platform; *MirusImage-Mac*, *MirusImage-DOS*, and *MirusImage-Windows* cost \$395 each.

List Price: FilmPrinter Plus, \$5,995. Mirus Corp., 4301 Great America Pkwy., Santa Clara, CA 95054; (408) 960-9770.

CIRCLE 450 ON READER SERVICE CARD

Touchbase Adds MNP5 Modem to WorldPort Line

NEW

The WorldPort 2400/MNP portable external modem, which supports the MNP Class 5 error-correction protocol, weighs 7.5 ounces (including battery) and measures just 1 by

CONTINUES ON PAGE 56



THE BALANCE OF POWER: QUATTRO® PRO

	QUATTRO PRO*	Lotus 1-2-3* v 2.2	v 3.0
PUBLISHING			
3-D Graphs	✓		
Built-in draw package	✓		
Individual cell font control	✓	✓	
Shading and borders	✓	✓	
Print graphs & spreadsheets side-by-side	✓	✓	
CONSOLIDATION			
Multiple spreadsheet windows	✓		✓
Multipage consolidation	✓		✓
Keyboard and mouse support	✓		
Lotus 1-2-3 v 2.01 compatibility	✓	✓	✓
Spreadsheet	640K RAM	11	8
Capacity (NSTL) **	1Mb RAM	18	12
		NA	5
Price***	\$495	\$495	\$495

*Clip art from PicturePaks® by Marketing Graphics Inc. (MGI) **NSTL (National Software Testing Labs) measured spreadsheet capacity by counting how many years of data could be added to a spreadsheet. Large numbers mean greater capacity. Performance for v 2.2 is with Always attached. ***Based on suggested retail prices as of October, 1989.

"QUATTRO PRO seems to do the impossible: It maintains compatibility with 1-2-3; adds functionality that no version of 1-2-3 has and still runs large spreadsheets in 640K."

PC WEEK, September 4, 1989

"Borland squeezes such features as multipage consolidation, advanced linking, and live graphics into a package that runs on 512K systems with its Virtual Real-Time Object-Oriented Memory Manager (VROOMM®) technology."

InfoWorld, September 4, 1989

QUATTRO PRO, with a unique balance of power, does both advanced publishing and multipage consolidation.

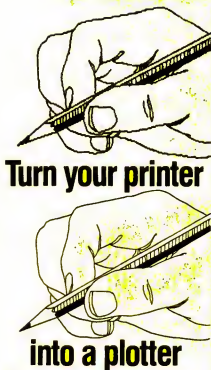
Lotus 1-2-3's Release 2.2 cannot do both. Neither can their Release 3.0 (see comparison chart).

QUATTRO PRO is compatible with 1-2-3.* It comes with a built-in draw package, clip art library,* and Bitstream® typefaces for presentation-quality output. QUATTRO PRO does it all today.

Publishing. Consolidating. Presenting.

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BORLAND



Imagine your present printer turning out crisp, high resolution plots while you continue to work, *without interruption*, at your PC.

The EGraph Plus add-on board lets you do that, and more.

You have total control over eight different line widths, and as many colors as your printer offers.

You can produce drawings 15 feet long, and longer, in any carriage width.

How about multiple plots, or automatic queuing of text and plots? Yes, the EGraph Plus lets you do that, too—with ease.

Think of it! Using virtually any CAD or graphics program, you can work at your PC while your printer generates plotter-quality drawings with nearly incredible detail.

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CIRCLE 341 ON READER SERVICE CARD

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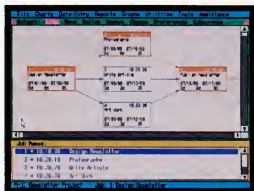
CONTINUED FROM PAGE 54

registered owners can upgrade to the new version by calling (203) 222-9150. MECA Ventures Inc., Westport, Conn.; (203) 226-2400.

Three New Aristocad Upgrades—Aristocad has introduced upgrades to three of its display-enhancement packages: *The Soft Kicker*, *The Soft Kicker Plus*, and *ExcelMore*. Version 2.0 of *The Soft Kicker*, the company's EGA/VGA display-enhancement package for *Ventura Publisher*, features an extended Magview box, which appears when the user is working in reduced mode. In Version 2.0, the Magview box can be scaled both horizontally and vertically and can be moved to other locations on-screen. *The Soft Kicker Plus*, Version 2.0, an upgrade of the utility that works with *Ventura Publisher*, *Microsoft Windows*, and *GEM* applications, now supports *Microsoft Windows/386*. Both upgrades also include an 800-by-600 color display driver and support for *DESQview 386*. Finally, Version 2.0 of *ExcelMore* supports *Windows/386*, as well. Version 2.0 of *The Soft Kicker* retails for \$99; current users can obtain the upgrade for \$35. Version 2.0 of *The Soft Kicker Plus* retails for \$139, with upgrades available for \$35. *ExcelMore*, Version 2.0, retails for \$99; upgrades are \$10. Aristocad Inc., Milpitas, Calif.; (408) 946-2747.

Project Scheduler 4, Version 2.0

The upgraded release of Scitor Corp.'s project management package offers several new multi-project options and support for expanded memory. Version 2.0 supports up to 2,000 tasks per project and 500 resource definitions; an unlimited number of task links and resource assignments can be made. Up to 500 independent projects can be loaded for multiproject management. Furthermore, the size of the Network Chart has been increased by 50 percent to accommodate the larger project capacity of the upgrade, and the package also includes a new Resource Allocation report that provides full cross-project resource reporting for selected resources. Enhancements to the package's scheduling capabilities include an Update Progress function, expanded Gantt Chart customization features, and an import/export utility that supports batch-mode operation. Furthermore, screen and report preferences can be saved and recalled, and printer and plotter selections can be changed directly from the program. *Project Scheduler 4*, Version 2.0, retails for \$685. Current users can upgrade from Version 1.5 for \$70 (plus \$5 shipping inside the U.S.). Those who purchased Version 1.5 of the program after July 1, 1989, can receive the upgrade free of charge. Scitor Corp., Foster City, Calif.; (415) 570-7700.



In *Project Scheduler 4*, Version 2.0, the Network Chart accommodates up to 500 projects.

C Tools Plus, Version 6.0—An updated library of functions for Microsoft C users, Version 6.0 of *C Tools Plus*, from Blaise Computing, offers programmers an assortment of new routines for developing C-based applications, including virtual, stackable menus and windows with full mouse support and optional drop shadows; multiple virtual pop-up help screens; a single function call that can move, resize, and promote a window or menu to the top of the stack; the ability to update covered windows automatically when they are written to; support for EGA, VGA, and MCGA text modes; and support for Enhanced-style keyboards. Programmers who need to integrate mouse support into windows and menus can take advantage of special routines to detect clicks and double-clicks and to adjust the timing with which the clicks are sensed. Furthermore, functions written in C can be installed so that they will be called whenever certain mouse actions occur. *C Tools Plus*, Version 6.0, retails for \$149. Current owners can obtain the upgrade for \$45. Blaise Computing Inc., Berkeley, Calif.; (415) 540-5441.



September 26, 1989
Paradox 3.0

"Torture testing at PC LAN Labs turned up a clear winner among the multiuser databases: Paradox 3.0" — PC Magazine, September 26, 1989

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When we win, you win. And that's just happened again.

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B O R L A N D

CODE: MX04

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PostScript Power For Your LaserJet. Only \$195.

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And PreScript runs up to five times faster than other solutions, particularly for graphics intensive pages and pages that switch fonts frequently. For even faster printing, an optional

PreScript interface card is available for use with the LaserJet Series II.

Plus, you get unlimited scalable, rotatable fonts along with all of the PostScript special effects, including support for powerful grey scale generation, character path, complex clipping, arbitrary image scaling and rotation, and curve drawing with flatness control.

PreScript requires no expensive printer controller. No extra printer memory. No external drivers. No soft fonts or font cartridges. No hidden costs.

So make your LaserJet take off for pennies. Power up with PreScript: 13 fonts (\$195); 35 fonts (\$395); optional interface card (\$195).

System requirements: 286 or 386 PC with 2 MB of extended memory; DOS 3.1 or higher; PreScript also works with the HP DeskJet and other HP-PCL compatible printers.

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PostScript Performance Without the High Price

CIRCLE 342 ON READER SERVICE CARD

New & Improved

WorldPort 2400/MNP

CONTINUED FROM PAGE 54

2.75 by 4.8 inches (HWD). According to Touchbase Systems, the 2,400-bps modem, which costs \$499, achieves an effective throughput of up to 4,800 bps. Compatible with Bell and CCITT protocols, the World-



The battery-powered WorldPort 2400/MNP modem has four LED indicators, including Carrier Detect and low-battery warning lights

Port 2400/MNP allows telephone connection through direct connect and acoustic couplers.

Other features include Hayes AT command set compatibility, auto-dial/auto-answer/auto-rate select, and an on-board speaker.

List Price: WorldPort 2400/MNP, \$499. Touchbase Systems Inc., 160 Laurel Ave., Northport, NY 11768; (516) 261-0423.

CIRCLE 428 ON READER SERVICE CARD

HP Offers Adobe PostScript Cartridge

NEW

Hewlett-Packard has incorporated Adobe's PostScript interpreter into a cartridge for the LaserJet IID printer. The \$995 cartridge contains 35 typefaces and gives IID owners access to the 500 typefaces of the Adobe Type Library. For single-sided printing, 2MB of printer memory is required; 4MB is needed for double-sided printing.

List Price: PostScript Cartridge for LaserJet IID, \$995. Requires: HP LaserJet Series IID printer, 2MB printer memory for single-sided printing, 4MB printer memory for double-sided printing. Hewlett-Packard Co., 19310 Pruneridge Ave., Cupertino, CA 95014; (800) 752-0900.

CIRCLE 441 ON READER SERVICE CARD

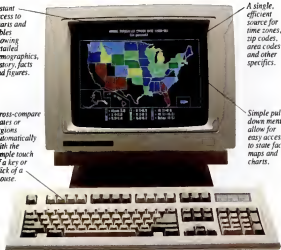
From purple graphic majesties to floppy waves of data. \$69.95

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Works with IBM® PC/XT/AT/PS2 and compatibles with a minimum of 512K RAM. Supports Hercules® monochrome, CGA, EGA and VGA displays. DOS 2.0+. Single floppy or hard disk. "PC USA" is a trademark of PC Globe, Inc. "PC Globe" is a registered trademark of PC Globe, Inc. © 1989

Many utilities thrive only on misfortune. PC Tools provides first-rate accident insurance plus much more.

Our desktop manager is one of our most noteworthy features. It has a word processor, database, autodialer, telecommunications and much more. Including a calendar to help you keep appointments, print out to-do lists, even graph your free time.



Our clipboard lets you cut information from your spreadsheet and paste it into your word processor (or any other application) without re-entering data or text.

Find files and preview them in their native formats (including 1-2-3 and dBase) in a fraction of the time it formerly took. Hit LAUNCH and your application and associated data file are automatically loaded.



A new visio

Accidents happen.

And when they do, nobody makes it easier to recover a deleted file or restore a hard disk than PC Tools Deluxe. But Central Point Software believes a utility product should do more than just protect you from misfortune. More than simply back up your hard disk, recover an inadvertently deleted file, or allow you to manage your files from a DOS shell.

Central Point's vision is that a utility product should enhance your productivity every moment you're at the keyboard. It should simplify the way you find, preview and load a 1-2-3 spreadsheet. Make it easy to combine the contents of one document into another. Even allow you to look up a client's address while you're in the middle of another application. Everyday tasks. Tasks that, without PC Tools Deluxe, are difficult to do and take far too much time.

But it's not just what PC Tools Deluxe does that makes it different. Its windowed environment makes doing these things (as well as all of its other functions) simple. The environment's movable, resizable win-

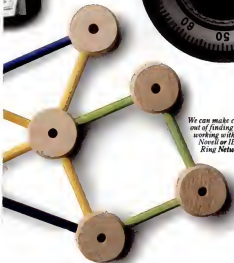


Our PC CACHE can accelerate disk intensive applications dramatically.

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n of utilities.

dows, full mouse support, pull-down menus and context sensitive help make learning and using the product a breeze. And PC Tools Deluxe conforms to IBM's Systems Application Architecture (or SAA) standards so its look and feel is almost identical to all the other applications you'll see in the 90s.

PC Tools Deluxe. It has redefined what a utility product should be. Designed not only to protect you from misfortune, but to make using your computer as fast and easy as it should be. So, even if you never have had an accident in your entire life, you'll still benefit from PC Tools the very moment you start using it.

PC Tools Deluxe 5.5
Central Point Software[®]

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**No matter which
of these modes you use,**

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40-column EGA Text
40-column VGA Text
80-column CGA Text
80-column EGA Text
80-column VGA Text
Lo-res CGA Graphics
Hi-res CGA Graphics
MDA Monochrome Text
80-column VGA Monochrome Text
Lo-res MCGA Graphics
Lo-res VGA Graphics
Med-res VGA Graphics
EGA Monochrome Graphics
Hi-res EGA Graphics
Hi-res MCGA Graphics
Hi-res VGA Graphics

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Magnavox introduces two new Professional Series displays that are fully compatible with all 17 VGA modes—both designed with the intelligence you've come to expect from Magnavox.

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400 for text, and 640 x 480 in 256 colors for graphics.

Both displays have a 14" CRT, versus the 12" industry standard. And both come with a built-in tilt/swivel base and are backed by a 2-year limited warranty—twice as long as most other brands.

At \$229 for the 7BM749 paper-white monochrome and \$649 for the 9CM082 color display, Magnavox makes VGA displays affordable.

MAGNAVOX
Smart. Very smart.

by
Gus Venditto

Pipeline

A Look at the Trends Shaping the Personal Computer Market

IBM Reacts to Impending EISA Machines with 64-bit Micro Channel Modes

The first clear result of the EISA consortium is here, although it's not quite the effect that the Gang of Nine was trying to achieve. Extended Industry Standard Architecture machines won't go on sale until late November or December, but the design

is already squeezing more performance out of machines it's designed to compete with: IBM's Micro Channel PS/2s.

In October, IBM debuted protocols that will allow far higher data-transfer rates on existing Micro Channel computers. IBM calls this a strat-

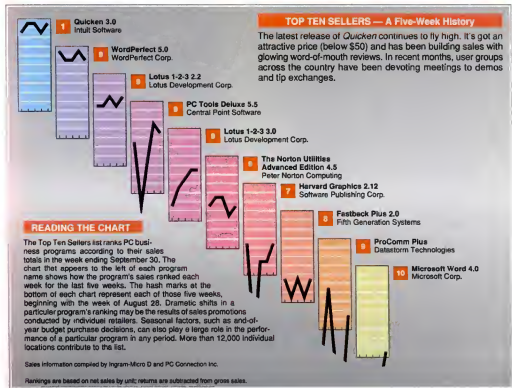
egy that will give Micro Channel systems adequate room for growth through the '90s, and while these enhancements were hinted at in years past, there seems to be no compelling reason to announce them now other than to overshadow the impending arrival of EISA machines.

The new protocols allow two new data-transfer modes across the Micro Channel. Both modes permit streaming data transfers, one at 32 bits and

the other at 64 bits, providing maximum speeds of 40 and 80 megabits per second, respectively. Today, a 20Mbps rate is the highest possible. Sixteen-bit PS/2s, like the Model 50 and 60, won't ever witness 64-bit data transfers, but the basic techniques will still work in these machines to push transfers at the highest rate the hardware will allow you to use.

The key to these new protocols is a reduction in the amount

CONTINUES ON PAGE 64



Pipeline

CONTINUED FROM PAGE 63

of addressing information that needs to be passed, thanks to three previously undocumented features: data-parity, address-parity, and synchronous-channel checks. With this verification subsystem in place, Micro Channel adapters can eliminate all but the first exchange of addressing information before sending data blocks, so streaming data transfers can roar across the bus once the initial address locations are exchanged.

In addition, there's a new bus-mastering protocol, Subsystem Control Block, that will aid devices that want to communicate across the bus without bothering the central processor.

EISA developers say they'll be able to match these features—if the demand materializes.

To help get these new protocols into products faster than the original Micro Channel cards, IBM has launched a partnership with Chips and Technologies to design the chip sets board manufactur-

ers will need to use bus-mastering techniques.

The fact that IBM has called on Chips and Technologies, a company that was created to reverse-engineer IBM hardware designs, indicates how much the market has changed in the last few years. When IBM introduced Micro Channel in 1987, it was protective of the new system's specifications, fearing that clones would take away its proprietary edge. Today, IBM is anxious to remove the proprietary trappings and encourage developers to do something—*anything*—for Micro Channel machines.

Zenith, Now Owned by Bull, Among the First with EISA
While HP is the first company to show an EISA PC (see preview on page 33), there's some irony in the plans of another EISA pioneer. Zenith will ship its Z386-33E by year's end, even though its new owner,

Groupe Bull, has invested in Micro Channel designs for the European market. Groupe Bull also owns G2, a key supplier of Micro Channel chip sets.

Meanwhile, prices for 1Mb and 256-kilobit DRAMs continue to slide.

Zenith Data Systems was recently spun off from its parent company, Zenith Electronics, and is now operating as a completely owned subsidiary of its French parent.

French parent, which also owns the Honeywell line of minis and mainframes. For the time being, Zenith Data Systems plans to proceed on the same course it's been following with portables and desktops—except that it will change its familiar lightning bolt logo; that has to stay with its former owner.

Toshiba, NEC Ramp Up 4Mb RAM Chip Lines
IBM took the lead in pioneering 4Mb DRAM chips, but the Japanese are now pulling out all the stops to satisfy demand for the new design.

Toshiba and NEC are both planning tenfold increases in production of 4Mb chips in the coming months, from a current level of about 100,000 units a month to 1 million chips monthly by next spring.

That's still far behind the companies' monthly production rates of 30 million 256-kilobit and 1Mb chips, so prices aren't likely to descend from the stratosphere for 4Mb devices till at least the end of 1990.

Meanwhile, prices for 1Mb and 256-kilobit DRAMs continue to slide. Retail prices for 100-nanosecond 1Mb chips have fallen from an average of \$38 last October to \$13 in June to \$11 at present. Over the same period, 100-ns, 256-kilobit chips have dropped from \$13.25 to \$4.50 to \$3.25. And SIMMs, which were impossible to find in single units last October, have come down about 20 percent since this June. (All prices were published in *PC Week* ads during these periods.)

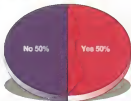
Prices for entire systems haven't yet caught up with these RAM price changes because computer makers had to stock up on chips when prices were high.



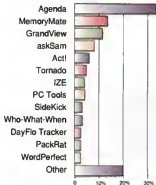
SURVEY

When personal information managers were first introduced in 1987, they seemed so unique that it wasn't clear whether any would be accepted. But in a recent PC MagNet poll, half of the 787 respondents said such programs were being used in their offices. A few people insisted on referring to word processors and disk utilities as their information managers, but overall there seems to be strong acceptance of the PIM concept.

Do you or others in your office use personal information managers?



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M is for Motorcycle



N is for Nutcracker



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Q is for Quack



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CAPCM 12.23

Bill Machrone



**New technology
always upsets
the apple cart.
But that can be a
good thing if
you learn to take
advantage of it.**

The personal computer is an instrument of corporate insurrection. Every organization has a bureaucracy dedicated as much to its own survival as to the survival of the organization. Every organization also has revisionists dedicated to motivating the bureaucracy to change. But until the personal computer revolution, the revisionists were hard pressed to do this.

A change in technology, however, is an ideal vehicle for implementing other needed changes. Just as legislative bills often carry a number of riders, new technologies can often invite tinkering with other aspects of the workplace.

I'll give you a personal example. In one of my former lives, I was the manager of compensation in the personnel department of a large insurance company (I know it's a strange background, but everybody has to come from somewhere). During my tenure, the powers that be decided that it was time to computerize the personnel department.

Even though I was a staunch supporter of the project, I wasn't sure how involved I might get with it. At one of the planning meetings, however, the folks from the systems department announced that they would need a user liaison. To my surprise, everyone at the table turned and looked at me.

Our new system was based on a computer-printed employee profile that would serve as a turnaround document for virtually every kind of personnel transaction, from changes of address to performance reviews and salary increases. First-line supervisors throughout the company would have to know how to fill out the document correctly before sending it up the line for approval. They would have to apply personnel policies and procedures to the letter to avoid having the document bounced back.

Much of the personnel policy manual had been written by a man whose goal in life was to reduce all written communications to the level of a dumb, belligerent labor attorney having a bad day. He was neither dumb nor a labor attorney, but with his guilty-until-proven-innocent attitude, he often had a bad day. He was backed by an equally Napoleonic assistant vice president, who added his own mea-

sure of obfuscation to the policies.

The fruit of their labors was written entirely in the third-person passive voice, with as many 19th-century legalisms thrown in as possible. The tone was somewhere between the insulting and the punitive. Needless to say, the personnel department was despised by operating management. I was determined to change that, using the new system as leverage.

SNEAK ATTACK

My weapon was the user manual. I figured that if people could understand the policies and the reasons for them, they wouldn't hate us for enforcing them. So I translated the policies into English and organized them by desired action. I outlined each of the procedures step by step. The bottom half of a page often had a reproduction of the relevant portion of the employee profile with sample entries.

Along the way, I streamlined many of the procedures, eliminating needless signatures and



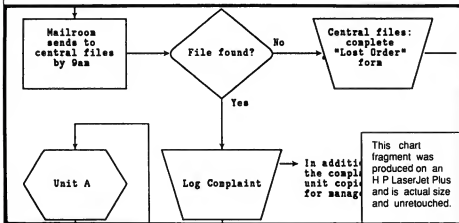
ILLUSTRATION: KURT RITTA

logging steps. Each procedure began on a fresh page of the manual, with a headline-size title and a cheerful logo in a contrasting color. In order to avoid the inevitable problems with the company's printing hierarchies, I desktop-published my work of samizdat, using a typewritten master and clear plastic overlays and transfer letters for the headlines. I had already put through the logo pages, having disguised them as a stationery print request. I ran the whole



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CIRCLE 201 ON READER SERVICE CARD

Bill Machrone

thing off on a high-speed Xerox machine after hours. It was beautiful.

In our system status meetings, I merely marked the user manual as "Completed." I had cartons of them stacked in the back of the records section. The system implementation date drew near. The first-line supervisors were all scheduled for training classes. Finally, my nemesis asked me if he could see a copy of the user manual. I brought one to his office.

I could tell from his immediate reaction that the bright blue-and-black logos, thumb indexes, and snappy binder didn't fit his image of what an official personnel document should look like. As he read through it, his expression became more and more morose. He challenged my language on several occasions, objecting to phrases such as "You will need to..." instead of "The supervisor in all cases must..." His big request was for me to redo the user manual with page references to the policy manual, "so people can refer to it," he said. My reply: "Why would they want to do that?"

Needless to say, the system was a big hit with management, to the point of applause in some of the training sessions. The company sorely needed the streamlining and procedural changes, and they simply wouldn't have happened without the new computer system. It affected the entire company.

LEARNING FROM EXPERIENCE

Today, of course, we can make the same kinds of changes, but at the departmental level, the workgroup level, and even the individual desk. You can get any number of people to tell you why something can't be done. And most will counsel you to make a change in slow, easy steps, when the right answer is to jump into the deep end and swim. We probably couldn't have come up with a plan to revise procedures as part of the installation of the new personnel system. The idea would have been beaten down as unrealistic, overreaching, or irrelevant.

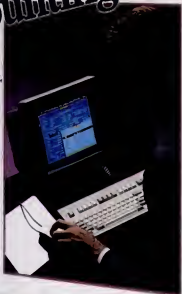

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CIRCLE 343 ON READER SERVICE CARD

PCM 12/12/89

John C. Dvorak



**Slowly but surely,
Microsoft is taking
over our industry.
Our industrial past
shows how this
can be stopped.**

Is Microsoft the only smart software company out there? The company recently bought Bauer Enterprises, the obscure maker of a PostScript clone. Microsoft hopes to pull off the same kind of coup that it did with IBM, when it bought the code to Seattle Computer Products' operating system for the 8086. That became PC-DOS. The rest is history.

This time, Microsoft is hoping to license the Bauer code to Apple and others now dependent on Adobe for PostScript. All PostScript laser printers rely on Adobe for software to drive the imaging engine. While those who sell \$20,000 typesetters don't mind spending a few hundred extra bucks for Adobe's outstanding PostScript software, continuously falling prices make PostScript prohibitive for the laser printer market, or so we are led to believe. Others know this and have tried to come up with a decent PostScript clone, but so far the results have been unspectacular.

Microsoft hopes to change this pattern by using its usual method, which is to throw a mediocre product into a sea of programmers to see what comes out. I guess it's easier than developing things from scratch. Except for *Microsoft Excel*, *Microsoft Word*, and the *Microsoft Mouse*, Microsoft has always relied on buy-outs or outside help to develop its products. It will buy the smallest of companies (Oakland-based Dynamical Systems, for example, a group of professorial experts that developed a character-based multitasking windowing environment). Its personnel then all disappear into the void in Redmond, and the product may or may not be seen again.

Company after company is approached by Microsoft in an eager effort to garner control of the industry. The original designs for MS-DOS, Xenix, *Flight Simulator*, the *Mach Accelerator* cards, and many other products were bought from outside sources by Microsoft, which then puts thousands of programmers to work writing updates and upgrades.

Most of these programmers are tickled pink just to be working under the same roof as Bill Gates. But Bill Gates knows that the best work is still done by hungry young turks in an attic who dedicate themselves to some code. In the process, will Microsoft become just another holding company like Computer Associates?

The mystery in all this is why other software companies aren't doing the same thing. Unless the industry wants to see Microsoft running all aspects of the software business, from operating systems to applications optimized for those operating systems, some other players had better figure out what's happening and take some action.

HERE'S THE PLAN

What's needed to rekindle competition is not Microsoft, but Megasoft. A new corporation. Microsoft is like the old Henry Ford-controlled Ford Motor Company. What we need is a modern Alfred Sloan and a General Motors of software—Megasoft.

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ILLUSTRATION: JEFFREY RITTA

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John C.
Dvorak

Inside Track

Perhaps the most important news in the industry is the sale of **Zenith Data Systems** to Honeywell-Bull, a foreign consortium largely owned by the French government. Supposedly, Zenith sold the computer division to concentrate on **high-definition TV**, a pic-in-the-sky pursuit if there ever was one. The Japanese are already broadcasting HDTV in Japan, but for some reason the TV companies who can't compete with Sony and Mitsubishi in regular TV somehow think they can compete in HDTV, even though they're already years behind. It mystifies me.

Zenith was a leader in both the laptop and desktop arenas. I was amused by the fact that, the day before the announcement, I was zooming through the channels on my TV (a Panasonic—ahem) and happened on the **Home Shopping Club** selling off a wacky Zenith EZ-2 personal computer with *Ability* software thrown in. The EZ-2 is kind of a clunky-looking PS/2 clone with dual 3.5-inch drives. They were selling it for \$798! Not a bad deal. I guess it was inventory that Honeywell-Bull wasn't interested in.

So how big was Zenith? None of the research data I found could tell me accurately what Zenith's position was in the race to be number one. One can assume that the company was right up there with **Tandy** and **Compaq** in the top tier of the PC business. Zenith had the government contracts sewn up, too. Things at Zenith began to go downhill after mastermind and supernegotiator **Bob Dilworth** left the company over rumored personality conflicts with a certain superior who, I'm told, enjoyed cussing out subordinates. Now, thanks to Honeywell-Bull, the guy can say, "Pardon my French!"

The big loser in all this is the consumer. When corporate buy-outs like this occur, the new owners never can identify the key players in the company before the key players use the changeover as an excuse to jump ship. This means key engineers will be off to join the competition in no time. For Zenith this means its top spot in the **laptop market** is in jeopardy. Most experts agree that this is the **hottest** segment of the market for the next few years. Zenith is number one. Why Zenith would relinquish its leadership role to chase an HDTV dream is the big question of 1989.

While on the Subject of Foreign Ownership Dept.: Foreign ownership isn't *all* bad. Or is it? A lot of people suspect that the Japanese are buying America, but Japan is a distant third or fourth in foreign ownership. England, Canada, and Holland are hogging the top spots. One survey has **Holland ranked number one**. Shell Oil and Philips-owned Magnavox are examples of Dutch companies. **North American Philips** and its interests in the audiocassette (it owns all

the patents), the CD, and, more recently, CD-I come to mind.

Philips recently bought **Vendex** and renamed the company **Headstart Computers**. I witnessed a rollout of its new low-end machines with **Leonard Nimoy** there narrating a long story in New York's Hayden Planetarium. One amusing aspect was the company's decision to move to Digital Research's **DR-DOS** (a completely MS-DOS-compatible operating system) as an alternative to MS-DOS.

Obviously there is some sort of **minifeud** between Microsoft and the huge Dutch electronics giant. It began, I'm sure, when Philips decided to roll out the CD-I (compact disc interactive) standard without even inviting Microsoft to any of the meetings. To make matters worse, it surprised Microsoft at Microsoft's own CD-ROM conference a few years back. To top off the insult, the CD-I system used Des Moines-based Microware's OS-9 operating system.

The next year, Microsoft made a point of supporting the DVI standard (a competitor to CD-I), developed by RCA Labs and subsequently sold to Intel. Exactly what triggered this back-and-forth **knife throwing** is unknown, but the trouble may precede the CD-I debacle. Some suspect that Philips distrusts Microsoft because of its close association with IBM, a company that seems to have a **bad image in Europe**. Ironically, Headstart will be **incorporating a CD-ROM drive** in its end-of-the-year new machines. I wonder why IBM hasn't gotten behind the technology. Microsoft must have been harping on it for years now.

Plugging My Book Dept.: I'll only do this once, I promise. Merely as an aside, I want to **plug my new book** on the subject of telecommunications, *Dvorak's Guide to PC Telecommunications* (Osborne/McGraw-Hill), a **killer definitive fat book with two floppy disks**—if I do say so myself. It's available at bookstores near you—demand a copy!

While researching the book, I discovered a ton of interesting developments. *HyperAccess/VI* is one of them. It's one of the most interesting telecommunications programs to come out in a long time. What impressed me the most about it is that you get **two versions** when you buy it—a DOS version and an OS/2 version. It's the only communications program that comes this way, designed to run on both operating systems and selling the two versions in **one package**. If this becomes a standard, then OS/2 will turn the corner of success and be a hit. This is a **great idea**. To make it even better, the program is outstanding and fun. A must-have for those interested in telecommunications, and for those using OS/2. It costs \$199. Call or write Hilgraeve, Genesis Centre, 111 Conant Ave., Suite A, Monroe, MI 48161; (313) 243-0576. ■

Perhaps things
at Zenith began
to go downhill
after mastermind
Bob Dilworth left
the company.

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Abstract

Location	Year	Physical Production (\$1000)	Value (\$1000)	Remarks
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	beginning 1967	12,000,000	\$12,000	Same as 1966
2. Saw Log, Fuel	ending 1966	6,275,000	\$6,275	Same as 1965
	beginning 1967	1,000,000	\$1,000	Same as 1966
3. Lumber Inventory	ending 1966	1,100,000	\$1,100	Same as 1965
	beginning 1967	1,100,000	\$1,100	Same as 1966

Source: U.S. Department of Commerce, Bureau of Economic Analysis, *Survey of Current Business*, 1967, 1968.

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Jim Seymour



The crisis in imaging models is a hot topic these days. Here's a look at the background of the problem.

Over the past year or so, a crisis has been building behind the scenes in the personal computer business. The impact of the alliances and answers now emerging to resolve this crisis will soon affect us all.

The crisis revolves around the problem of the differing imaging models used in PCs. An *imaging model* is the method a PC uses to send something to an output device, such as a computer's display, or to a printer.

When one system is used to draw output on a video display and another to draw the output of that same image on paper, discrepancies will inevitably occur. In word processing or desktop publishing, for example, a line may not break (wrap) at exactly the same point on paper as it does when you see the page displayed on the screen.

That didn't matter so much in the early days. We were very glad to get something—anything—on paper, even if the resemblance to what we'd seen on the screen was only marginal.

Indeed, disparate imaging models were built into the IBM PC from its inception. The text mode built into IBM's MDA (monochrome display adapter), for example, displayed letters and numbers on the screen using a character set stored permanently in a ROM chip on the adapter board. It neither knew nor cared what the characters looked like on paper—what typefaces were used or how big or small they were. Its only job was to put the text on the screen in a rigid 80-character-by-25-line grid. The *g*'s always looked the same, the *B*'s always looked the same, and so on.

That wasn't a problem back then, because the hard-copy output devices we used usually produced equally rigid results: printouts with plain, monospaced characters from daisy wheel or dot matrix printers. Sure, we could change to proportionally spaced output, use larger or smaller type, or even boldface and italicize text. But early PC software didn't support things like proportional spacing and microjustification very well.

However, it did work, sort of . . . and besides, what else was there?

Then, almost six years ago, came Apple's Macintosh. Here was a computer that showed

something like actual typefaces on the screen, and in something like their actual output size. Its display was crude but useful. And Apple soon followed up with the LaserWriter printer—the single biggest step in establishing the Mac as a real alternative to PCs.

POSTSCRIPT TO THE RESCUE

What made the LaserWriter fly, of course, was its built-in PostScript interpreter. Two guys named Warnock and Geschke, who had worked on a so-called page description language while at Xerox, left to form Adobe Systems, where they created a much better one: PostScript.

By representing type as a set of mathematically described outlines rather than as traditional bitmapped characters, PostScript made it possible to scale the type up and down. This meant that a single stored *g* in, say, the Helvetica typeface could be reproduced in almost any size, from incredibly small to bigger than you'd ever want.



ILLUSTRATION: ALBERT RITA

Unfortunately, PostScript's sophistication was not matched by QuickDraw, the screen-management toolbox Apple provided in ROM in the Macintosh. So while the LaserWriter could generate Helvetica type in any size you wanted—say, 17.5-point—you couldn't get a decent display of it on the Mac's screen unless you stored a bitmap of exactly that size in the System file, the Mac equivalent of DOS.

Since those font-size bitmaps took up a lot

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Jim Seymour

of storage space, which meant that the System file could accommodate only so many of them, users tended to stick in just a couple—say, 10-point and 12-point bitmaps for each typeface they used. QuickDraw could produce at best only a vague representation of characters in other type sizes, through a coarse extrapolation of the stored bitmaps.

This problem hardly held back the growth of the Macintosh—after all, there was always that great-looking LaserWriter output. But it did mean that working with text on the Mac left a lot to be desired. *Page-Maker* users who tried kerning large-size type—removing tiny slivers of excess space between T's and o's, for example—found they couldn't trust the screen display. They were forced to do frequent trial print runs on the LaserWriter to really see what they were doing.

DIVERGING SOLUTIONS

Apple wanted something better, and Adobe sensed a marketing opportunity, so Display PostScript appeared. It used the same font outlines as the PostScript built into the LaserWriter, and it drew them on the computer's display with amazing accuracy. Now, finally, what you saw (on a personal computer's screen) could truly be said to be what you got (on paper). WYSIWYG forever!

Display PostScript did not exactly take off, however. Complaints about its alleged performance shortcomings (it takes a lot of computer power to scale those outlines and then push all those pixels around on-screen) and Adobe's license fees (outrageously high, many claimed) dragged it down. Steve Jobs has chosen it for his new NeXT computer, but otherwise, Display PostScript remains an orphan. Because Apple rejected it.

Instead, Apple took a different path, announced in May this year. The new System 7.0 release of the Macintosh operating system, now due in the first quarter of 1990, will contain font outlines at the system level, and those outlines will be used to draw both screen- and paper-output characters.

Voila! Finally! A true, integral, single-imaging model!

Next time: how Adobe's and Apple's technologies, and their nasty brawl, have moved into the IBM PC world. ■



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William F. Zachmann



The next few years will be rough for vendors as the market awaits the powerful new applications of the future. Making a profit will require new assumptions.

Personal computers have undoubtedly had a dramatic impact in the 1980s, in which they've gone from being something of an oddity used by a small number of enthusiasts to a ubiquitous business tool used by millions of ordinary people.

As we approach the end of the decade, substantial ferment is roiling the industry. The advent of true 32-bit microprocessor-based systems, the battles of OS/2 and Unix and of Micro Channel and EISA, the shift to graphical user interfaces, SQL, and object-oriented programming, and numerous recent efforts to define standards for communications, data exchange, and just about everything else, are all signs of the turbulent times we live in.

Yet much remains the same. Word processing and spreadsheets continue to dominate the sales and use of software, and the market shares claimed by database management, communications, and graphics software are similar to what they were in 1979. Despite lots of fascinating new products, none, so far, has had an impact anywhere close to that of the dominant software categories. We seem to be simply using more powerful hardware to do the old jobs better.

Eventually, the convergence of better basic hardware with newer technologies, such as optical disk storage, image-manipulation techniques, and simulation, will open the door to entirely new classes of applications. But it would be premature to expect this to happen over the next two or three years. At best, we may be able to identify crude prototypes of the kind of software that will emerge, but it will be several years before hardware technology matures enough to make such radically new applications affordable to large numbers of users.

This does not mean that the early years of the 1990s are going to be just more of the same. On the contrary, the major advances in the use of personal computers will come in a different direction from those that have dominated the past.

Until now, personal computers have been used most of all as personal productivity tools. PCs have proven themselves to be

enormously useful to managers, executives, scientists, engineers, secretaries, and salespeople. Old-fashioned handwritten, typed, or dictated reports and memos and 13-column pads have been rendered all but obsolete, and tasks that once took hours or days are now routinely accomplished in minutes.

DECEPTIVE ASSUMPTIONS

But the very success of PCs at these tasks has made them so widespread as to limit their potential for future growth. Comparing the total number of personal computers in service with the total number of white-collar workers, as is done by many market research firms, is in fact very misleading. Despite claims to the contrary, the PC market is actually quite close to saturation when allowance is made for the fact that the proportion of the work force that can really make use of PCs is more like 50 percent than 100 percent.

As a result, most of today's PC market is



now a replacement market, in software as well as in hardware. For most vendors, first-time buyers are no longer where the action is. To succeed in selling a new computer, peripheral, or application today, a vendor must be able to convince us that it is significantly better than the computer, peripheral, or application that we are already using.

That's why so many vendors have been having such a hard time sustaining revenue

William F. Zachmann

growth and profitability levels recently. As we approach the top of the S-curve that marks the adoption of personal computers, its decreasing slope makes it tougher and tougher for vendors to maintain the steep growth rates characteristic of the middle of the curve.

Many of them respond by chasing will-o'-the-wisps like the next great application category or the miraculously easier-to-use interface that will bring computers to the masses. Unfortunately, there isn't going to be a great new application category any time soon. And among the masses, those that are interested in computers have already got them.

Simply put, vendors who want to grow faster than the industry in general are

going to have to offer products that are both sufficiently better and sufficiently lower-priced to make us want to replace what we've already got. Those that do this will succeed; those that don't, won't.

Vendors who want to find new avenues to growth won't be able simply to plod along the old course of selling individual productivity applications. New paths must be taken, the most important of which will be in the direction of providing the tools we need to replace main-frame and minicomputer systems with microprocessor-based alternatives. For it is precisely in these enterprisewide computing tasks that the greatest growth opportunities will be found.

The primary task for the early '90s will be to put inexpensive microprocessor technology to work doing the jobs that until recently have belonged to much more expensive traditional systems. And for those whose professional livelihoods

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depend on using and supporting personal computers, the years ahead will bring a host of new challenges and new opportunities. These, in turn, will require approaches and solutions far different from those that were adequate for helping individuals to use PCs for personal productivity.

The concept of the personal computer merely as a tool for the individual or as an individual gateway to a traditional system simply isn't adequate. We need to rethink the very nature of information systems in the organization as a whole, and the full range of options that personal computers now present in them. I'll elaborate on these topics in future columns. ■

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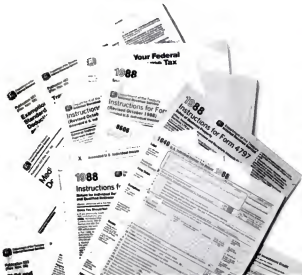
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Stephen Manes



The world of hardware offers more than just clones and monitors. Inventive niche products let you turn the wires in your wall into a simple network or give vent to your creativity in tombstone design.

Barely gasping and wheezing in the software world, the spirit of invention is alive and well in the land of hardware. It's clear every time you attend a trade show, tour a high-tech venue, or sit home and peruse the ads. Software stays home and rewarms stale hash; hardware keeps taking small steps and major strides forward.

True, there's no dearth of me-too machinery. True, there are plenty of yawner clones of everything from motherboards to monitors. But lately hardware seems to move forward with far more verve and sparkle than its intangible sibling.

This makes sense. Software designers are doomed to live with the limitations of the hardware they write for. Hardware designers are under no such constraints; in fact, their innovations keep creating entire new software categories.

Cheap laser printers led to desktop publishing. Cheap scanners have empowered optical character recognition. Emerging audio and video hardware may change software's very face. If you're inventive, you won't wait for some hardware developer to make your dream possible; you'll go out and build the dream yourself.

Big Ideas aren't all that's happening in hardware. What's impressed me most lately is a variety of Little Ideas—conceptually simple products aimed at relatively narrow markets. Every time I stroll past a bunch of trade-show display tables, it's a likely bet I'll see some sort of goofy piece of hardware that isn't going to set the world on fire, but that might just make somebody's day.

My current personal favorite is CAMM-1 Desktop Sign Maker (\$4,495 from the Roland Digital Group; (212) 722-6933), which offers the potential to be a lot more than its innocuous name implies. It's the answer to a single simple question: What if you take a plotter and replace the pen with a knife? Answer: A truly whiz-bang stencil cutter.

A roomful of editors recently sat transfixed as the CAMM-1 sliced, carved, and spat out a nice blue adhesive-backed plastic stencil rendition of our magazine's logo. No computer was attached; the device has its own nonvolatile memory, so that repetitive production runs

can be completed entirely off-line. The stencil is now affixed to the back of one editor's laptop machine.

The CAMM-1 responds to the standard HPGL plotter language, so it's compatible with a broad range of software. It can double as a single-pen plotter simply by swapping the swivel knife for a pen.

GOOD FOR THE MOB?

And the CAMM-1 isn't limited to plastic sign stock. It can cut materials of all sorts, including silk-screen stencils, reflective window coatings, and heat-transfer (T-shirt) material. Think how handy an automobile customizer might find software that spews out window-gloomers for the mob's limos at the push of a button.

But I personally believe the stuff that really has the chance to catch on is resist material for etching and sandblasting. Think of it: your local K mart lets you design your own personal glassware. Think of it: your local funeral parlor offers you the chance to customize your



own personal grave marker. I call these concepts "Desktop Barware" and "Desktop Tombstones"; franchises will be available soon.

I haven't actually tried the CAMM-1, but I suspect it will eventually turn up in quick-print shops. And I haven't even seen the CAMM-2, an engraving machine controlled by HPGL commands, or the CAMM-3, a 3-D modeling machine that accepts CAD/CAM output. But

Stephen Manes

these are the kinds of products that make the hardware world fun to keep an eye on.

I have tried CarrierNet, a unique RS-232 network from an outfit called Carrier Current Technology (telephone: (800) 222-0377). It, too, is based on a simple idea: letting computers communicate via existing electrical wiring.

The CarrierNet hardware is a box with two cables. One plugs into a PC serial port, the other into any AC wall socket. Hook up the boxes and install the supplied *ExcelINET* software—it takes maybe 10 minutes per machine—and you're ready to communicate. The only wires linking the machines are the AC wires already in the walls. \$199 per unit buys the hardware and printer-sharing software; \$79 more adds file sharing.

The concept, as so often happens, is somewhat better than the reality, in part because the software is kind of ugly. Though your applications can't access files on other machines, you can share files via DOS-like commands, and printer sharing

seems fairly effortless. The system comes set for a default speed of 19,200 bits per second, but you can get it running at up to 38,400 bps if your wiring permits—which it did (for a time) in my abode. You'd also better consider security very carefully if you share a building with snoops.

LITTLE DEMONS

A host of little demons may gum up the works, however. The company recommends not plugging the AC end into a surge protector—to avoid filtering out the signals it transmits. Since the hardware deliberately generates radio frequencies, it clears only FCC Class A specs rather than the more stringent Class B. Transmissions are error-checked, but certain kinds of line noise, including radio noise from outdoors, may slow things to a crawl or stop them cold. The network's memory overhead amounts to an all-too-typical 90K.

Immediately after installation, CarrierNet ran at a snail's pace. As I discussed the problem on the phone with company representatives, the network magically began to work fine for no apparent reason (talk about customer service!). Thenceforth, I

was able to send files from upstairs to downstairs, print from downstairs to upstairs, and generally feel pretty smug for someone who never thought he'd use or like a network. As a test, I ran an electric fan and a hair dryer; no problems.

At deadline, newer versions of hardware and software arrived via express. They wouldn't work acceptably, and this time the magic phone call didn't work, so "try before you buy" is in order. Still, I like the product enough to fool around with it some more.

And those two products are merely examples of the hardware boom. An outfit called Photonics is offering a full-scale wireless LAN that uses infrared transmission. Every week seems to bring announcements of jazzy new presentation aids—everything from the Chisholm Light Writer (an overhead-projection LCD you can draw on electronically) to Canon's poster-size, freestanding, black-and-white mylar display. By the time you read this the market should be awash in itsy-bitsy, teeny-weeny DOS machines.

And on the software side? Ah, yes: the mailman just delivered another new word processor and two new DOS shells. ■

EEEEEEK!

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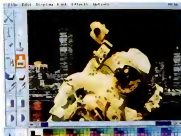
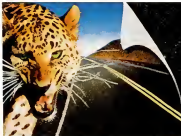
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AN IDEAL TEACHING TOOL

RightWriter is also an ideal teaching tool. It's like having a style guide and grammar book right at your fingertips. As it helps you improve a document, RightWriter also trains you in the principles of good English. So it's an excellent training tool for business and education.

RightWriter teaches you by pointing out errors in your own writing, rather than giving you canned textbook examples.

YOU'LL SEE THE RESULTS...

When RIGHTWRITER identifies a problem, it's also encouraging you to think about it—you'll be less likely to repeat the same errors. Some people don't even know they're learning...they just notice fewer errors in their writing every time they use RightWriter.

RightWriter helps you produce crisp, clean business writing—and just a one-word command puts it to work. RightWriter flags errors in use of passive voice, split infinitives, syntax and proper use of punctuation. Have more confidence and pride in your writing.



Your Original

The current status of dealer sales is terrible. Our traditional dealer sales strategy does not seem to be working. Current sales figures seem to be indicative of a major problem. In view of the fact that the entire company's future depends on dealer sales, this problem must be solved upon expeditiously to develop a multiplicity of solutions to overcome the problem (i.e., better point of sale material, more market research, more support by rep., etc.).

The current status of dealer sales is terrible. Our traditional dealer sales strategy does not seem to be working. Current sales figures seem to be indicative of a major problem. In view of the fact that the entire company's future depends on dealer sales, this problem must be solved upon expeditiously to develop a multiplicity of solutions to overcome the problem (i.e., better point of sale material, more market research, more support by rep., etc.).

OVERALL CRITIQUE FOR: 1000
READABILITY INDEX: 11.38
Readers need an 11th grade level of education to understand this writing.
SYNTAX INDEX: 0.00
The writing can be made more lively by using:
-the active voice
-the shorter sentences
DESCRIPTIVE INDEX: 0.01
-adjectives and adverbs is within the normal range.
- 43 - of jargon.

RightWriter 3.1 \$79

A QUICK LOOK

RightWriter helps you produce clean, powerful writing. With just a one-word command, RightWriter scans your document for errors in grammar, style, usage and punctuation.

Specific Recommendations

RightWriter flags common writing errors such as passive voice, noun-verb agreement and more.

Readability And Strength Index

The Readability Index shows the educational level a reader requires to understand your writing. The Strength Index measures your writing's strength.

Parts Of Speech And Sentence Structure

Other indexes measure your adjective and adverb usage, and use of jargon. Recommendations guide you in how to improve your sentence structure.

Words To Review

The Words To Review list points out problem words that could cause confusion in your writing.

RightWriter Now Includes—FREE...

RightWords! A \$30 Value

Customize RightWriter's vocabulary to suit your individual needs. Jargon, abbreviations and accepted slang can be recognized—and will not alter the readability or strength levels.

RightWriter Grammar Checker From TigerSoftware

DB 2860 RightWriter 5% AND 3% \$79.00

Runs on IBM PC, XT, AT and compatibles with 384K. Hard disk or floppy. Supports all leading word processors. Call for compatibility.

RightWriter's
Summary
Critique

ALL-NEW!**VERSION 3.1**

NOW WITH AN EXPANDED
RULE BASE OF 4,500
RULES WITHIN WORDPERFECT

NOW IT'S AS EASY TO CHANGE SOFTWARE AS IT IS TO CHANGE CHANNELS ON YOUR TV!

Now Load Several Programs At Once And Switch Between Them—Instantly!

Make All Of Your Programs "RAM-Resident"

Imagine being able to switch instantly from one program to another! Let's say that you're working with your word processor and you need to check a figure in your spreadsheet. Normally, you'd have to exit your word processor, start your spreadsheet, load the necessary file, jot down the numbers you need, save and exit the spreadsheet. Then, you would have to start your word processor again, reload your file, find your place and continue working. That's a lot of work!

Saving, exiting, starting, loading and retrieving are eliminated! Software Carousel installs in seconds and allows you to change programs and files as quickly and easily as you change channels on your TV. So, in our example above, you could have "hot-keyed" from your word processor to your spreadsheet file, got the information you needed, and with one keystroke, you're back in your word processor—in the exact spot you left off! **Replaces 10 time-consuming steps with just 2 keystrokes.**

And Software Carousel is compatible with virtually any PC software on the market today!

IT WON'T "Gobble" MEMORY! Would you be amazed to learn that Software Carousel requires just 11K (as a memory-resident extension of DOS) to achieve such efficiency? It's true.

Just insert the diskette and type "carousel." Then load all of the programs you'll be working with. By keeping your programs in a special area of memory, you'll access ALL available memory for all programs and files.

So simple, anyone can use it. Software Carousel automatically remembers your setup and repeats it each time you start your computer. Software Carousel is pure productivity!



Software Carousel With FREE CUBIT Just \$69.95

A QUICK LOOK

- ✓ Simple to install and use. Software Carousel allows you to switch from one program to another—with one keystroke. Saves time—you don't need to save and exit files before switching.
- ✓ Makes all your software "RAM-resident," just hot-key between anything loaded!
- ✓ Occupies just 11K RAM.
- ✓ Run SideKick, SuperKey and ProKey—at once—with no interference or conflict.
- ✓ Go from spreadsheet to database to word processor—in seconds!
- ✓ Supports expanded and extended memory boards.



FREE—CUBIT!

Return the coupon enclosed in the Software Carousel package for FREE Cubit!

SOFTWARE CAROUSEL

DB 3300 Software Carousel—IBM 5¼-inch....\$69.95
DB 3305 Software Carousel—PS/2 3½ inch....\$69.95
Runs on IBM PC and compatibles. Supports DOS 4.0.

Includes **SideKick** Software from Borland (A \$79.00 Value!)
Also Includes **PC Advantage** from Travelling Software (A \$130 Value!)

The Hand-Held PC!

Just \$119.95—But You'd Better Hurry! The DataStor 8000 is the latest innovation in state-of-the-art technology. Its large memory capacity allows you to enter up to 128 characters per entry. Your information can be saved in DataStor for later use, or you can easily transfer data to your IBM or compatible PC (or another DataStor) using an adapter cable that is included. So names you collect at a convention using DataStor can be transferred into your permanent database for use in follow-up mailings.

Use **SideKick** and **PC Advantage** (included FREE) with your DataStor—or download software from your desktop PC!

Hand-Held Computing.

With DataStor, you get a notepad, desktop organizer, appointment calendar and stand-alone calculator. In fact, with 8K of available memory, it's like having a PC—in your pocket! But what makes the DataStor 8000 so convenient is its ability to actually transfer data to an IBM or compatible desktop PC.

DataStor includes eight mode indicators that light up in the LCD displaying the mode in use. It also includes a full-function calculator and time/date indicators.

The 16 message alarms can be pre-set up to a year in advance. They can alert you to

Microlytics, Inc.

Download notes, numbers—even your existing PC software

✓ **INCLUDES SideKick Software** download (BASE and most word processors).

✓ **ELECTRONIC SCHEDULER** Plan your day with a daily organizer. Quickly "jot down" notes or memos anytime.

✓ **PHONE/ADDRESS DIRECTORY** Store ALL of your names and addresses for instant access—or enter new ones and download to your desktop PC later.

✓ **MESSAGE ALARM** Preset up to 16 reminder alarms—for appointments, phone calls or engagements—up to a year in advance!

✓ **CALCULATOR/CLOCK** Check time, date

appointments, birthdays etc. When the time and date of your message occurs, DataStor sounds a 20 second tone, during which the pre-programmed message appears in the LCD screen.

DataStor also includes a security feature that insures your entries will remain private. There is also a back-up feature to protect data when changing batteries.

It's like having a Rolodex,® and a DayTimer® in a convenient hand-held format.

Technical Features:

- ✓ The DataStor 8000 includes a database, data exchange software for use with your desktop IBM PC, XT, AT PS/2 or compatible, and cable.
- ✓ Includes Personal Organizer Software—Set up a customized planner to fit your needs.
- ✓ Large 20-character screen — 8K capacity
- ✓ 760 characters (300 name and number entries).
- ✓ Security codes to keep entries private
- ✓ Auto-OFF after 2 minutes — Battery back-up

DataStor 8000 The HAND-HELD PC

DB 2480 DataStor software and cable.....\$119.95
Leather-like case, cable, battery and back-up battery included.



The Organizational Chart—A Valuable Management Tool...

Organizational Charts, Procedure Diagrams, Decision Trees And More!

How do you describe your company to new employees, or possible clients? Chances are, you devote pages of text in personnel manuals and sales presentations to management levels and work flow. Since **a picture is worth 1,000 words**, the organizational chart is an ideal method of depicting a hierarchy, procedure or method—but charts involve making a layout, setting type, inking boxes—and revisions are murder!

Fast Charts For Any Purpose! Now you can create charts in a matter of minutes—to illustrate anything! Policy making, responsibility delegation, authority levels, flow charts, procedure diagrams, decision trees—or for use in sales presentations.

We completed our first chart 11 minutes after opening the box! Sleek, easy-to-use box drawing capabilities make Corporate Ladder simple—just type your text and one keystroke draws a box around it! Group boxes with another keystroke and revise charts in seconds. Change paper—and Corporate Ladder adjusts the chart size automatically! It even has an on-screen WYSIWYG display! **For FREE**—We'll throw in a copy of the popular Corporate Ladder Laser Font-Pack—A \$29.95 value. (See below for details.)

IT'S EASY TO LEARN AND USE No rigid formats or pre-defined templates that you must work within. Just start typing. Corporate Ladder will automatically justify your text and draw boxes around it. Put the finishing touches on your first chart minutes after opening the box!

CREATE ANY TYPE OF CHART Quickly create charts like this one—a decision tree—to depict your company's policy on certain procedures.



UNIQUE "FINISHING TOUCHES" FEATURE Once you've completed the layout of the chart, Corporate Ladder will automatically center text, center lines and align boxes. It even consistently spaces the elements of the chart.

INCLUDES LASER FONT-PACK—FREE! The Laser Font-Pack includes two additional typefaces (Courier and Modern Letter Gothic) and allows four additional sizes ranging from tiny (25 cpi) to oversize (8 cpi). All fonts supplied in normal and sideways formats.

Corporate Ladder \$79.95**A QUICK LOOK**

- ✓ A fast, easy-to-use package that creates clean, professional-looking **organizational charts**—or any type of chart!
- ✓ Just type text and one keystroke draws a box around it—with every corner crisp. Features page preview and unique "Finishing Touches" feature that refines and properly spaces your chart.
- ✓ Also creates decision trees, procedure diagrams, maps and product families.
- ✓ No rigid structure—ideas flow freely and can be revised in just seconds.
- ✓ Includes a set of 4 **FREE** laser fonts to enhance the design of your charts!

**Corporate Ladder
Organization Chart Maker**
With FREE Laser Font-Pack!

DB 4850 IBM 5¼ AND 3½-inch.....\$79.95
IBM PC, XT, AT, PS/2 and compatibles with 512K RAM. Support virtually any dot matrix printer—including the HP LaserJet Plus or Series II

**Supports Most Dot-Matrix And Laser Printers!
Even Supports Plotters!**

Corporate Ladder
The Fast, Easy Organizational Chart Maker
That Draws Procedure Diagrams, Decision Trees, Maps and More

THE FASTEST, EASIEST CHART MAKER!

INCLUDES FREE—LASER FONT PACK!

WE SHIP SAME DAY VIA FEDERAL EXPRESS—FREE!**CALL US TOLL-FREE AT (800) 888-4437**

PERSONNEL POLICY EXPERT—Developed By Human Resource And Labor Law Professionals...

Software To Quickly Create Authoritative Employee Handbooks—Protect Your Employees—And Your Company.

Human resource and labor law experts agree that one of the most important documents your company will ever publish is the employee handbook.

A professionally-written policy handbook clearly defines an understanding on areas such as non-discrimination, employment termination, pay periods, smoking, medical leaves of absence, overtime, performance, behavior, and drug use in the workplace.

HOW THE SYSTEM WORKS...

Personnel Policy begins by focusing on the significant issues of over 60 policy topics. It asks key questions about your specific situation and actually writes an employee handbook tailored to your needs. The built-in word processor gives you complete control over each policy's final wording.

EASY TO LEARN AND USE...

Although you'll want to give your employee handbook careful thought, actually putting together the handbook is just a matter of following the menus on the screen. You'll be well on your way just minutes after opening the box!



"Takes the pain out of creating employee handbooks... a time-saving, easy-to-use tool." —PC Magazine

AUTHORITATIVE, UP-TO-DATE INFORMATION...

Includes human resource and labor law information on over 60 important policy subjects. The system offers explanations of each topic, the pros and cons, legal requirements and standard business practices. These discussions provide insight on possible ramifications of policy decisions. And Personnel Policy Expert is updated every six months to reflect changes in state and federal regulations.

IN USE AT MAJOR CORPORATIONS...

Personnel Policy Expert is in use in such corporations as Canon Business Machines, Pioneer Communications, MCI Communications, The National Broadcasting Company, Coldwell Banker, Budget Rent-a-car, Labatt Brewing Co., Dow Chemical, The New York City Criminal Justice Agency, and many more.

TigerSoftware SPECIAL!

Regular Price: \$495.00

NOW JUST \$395.00

OVER 60 POLICY SUBJECTS INCLUDING...

- ✓ AIDS in the workplace
- ✓ Attendance and punctuality
- ✓ Conflicts of interest
- ✓ Drug and alcohol use
- ✓ Educational leave
- ✓ Employee benefits
- ✓ Conduct/work rules
- ✓ Employment termination
- ✓ Hiring of relatives
- ✓ Holidays
- ✓ Jury duty
- ✓ Maternity-related absences
- ✓ Medical leave
- ✓ Resignation
- ✓ Return of property
- ✓ Safety
- ✓ Security inspections
- ✓ Severance pay
- ✓ Sexual/other forms of harassment
- ✓ Sick leave benefits
- ✓ Smoking
- ✓ Use of phone and mail
- ✓ Use of vehicles
- ✓ Vacation benefits



Personnel Policy Expert

DB 9000 IBM 5¼-inch.....\$395.00
 DB 9005 PS/2 3½-inch.....\$395.00
 IBM PC, XT, AT PS/2 and compatibles, 512K RAM.

SEE Your Documents Before You PRINT Them....Save Time, Paper, Toner, Ribbons—And Money!

PrintVision WYSIWYG FULL-PAGE PREVIEW! ENHANCES CREATIVITY, ACCURACY

SEE your documents—AS THEY WILL PRINT!

With new PrintVision—a "graphics-like" preview utility that allows users to actually preview word processing documents, database files, spreadsheets, mail merge lists, charts, forms and more with a What You See Is What You Get—preview display. Catch errors in layout, spacing, font changes and character sizes—before committing them to paper! Save time and money!

BLOC Publishing

PrintVision WYSIWYG Preview Utility

DB 2300 PrintVision IBM 5¼ inch.....\$69.95
 DB 2305 PrintVision PS/2 3½ inch.....\$69.95

Runs on IBM PC, XT, AT, PS/2 and compatibles. Requires 64K memory. Will support CGA, EGA, VGA and Hercules. Supports HP compatible laser printers. Call for details.



NORMAL WORD PROCESSING FILE DISPLAY...

With text-based programs all you see... is plain vanilla text. When you create letters, forms, charts, spreadsheets and lists, you won't know exactly what you've got—until it's too late.

PRINTVISION DOCUMENT PREVIEW...



CALL TO ORDER—(800) 888-4437—TOLL FREE!

THE MEMORY MANAGEMENT DEPARTMENT

Introducing PopDropPLUS...A Breakthrough Concept!

For The First Time—You Can Load RAM-Resident Programs Into EXPANDED Memory!

PopDrop For Managing RAM-Resident Programs In Conventional Memory.

PopDropPLUS Includes PopDrop AND PopLoad—For Loading RAM-Resident Programs Into Expanded Memory.

(PopDrop available separately for users without Expanded Memory)

Shatter The 640K Barrier! Now, in one package, the software solution to the downside of DOS—its crippling memory limitations. PopDrop and PopDropPLUS give users the ability to manipulate RAM-resident programs in 640K RAM, as well as the ability to break 640K and load RAM-resident programs into Expanded memory.

Not just another slow, inefficient "swap-ping" utility, PopDropPLUS allows your RAM-resident programs to run just as fast as they do when loaded into conventional memory.

THE MEMORY LIMITS OF DOS...

As software applications like word processors, databases and spreadsheets have become more powerful and productive, they have become more memory-hungry as well.

THE SOLUTION.

PopLoad actually allows you to load up to 50 of your RAM-resident programs into Expanded Memory and execute them from within any application—even if the RAM-resident programs do not support Expanded memory!

FATTEN YOUR RAM.

Your lower 640K of "conventional memory" is free to handle your larger applications without conflict or interference.

With PopDrop and new PopDropPLUS, "RAM-resident" is no longer a dirty word.

This is the only product that truly shatters the 640K barrier while still delivering instant control of RAM-resident programs...



PopDrop PLUS also includes a utility that allows you to remove, replace, deactivate and reactivate spell checkers, thesauri, keyboard macro programs, print spoolers, desktop organizers, notepads, calculators and more—without rebooting! PopDrop eliminates memory and keyboard conflicts that result from loading certain RAM-resident programs together.

PopDrop will support networks and won't interfere with any of your other programs.

Eliminate RAM-Resident Conflicts.

PopDrop works by dividing your memory into layers—up to 16—each of which may contain several programs. After loading DOS and your permanent programs, RAM-resident programs are loaded with these layers between them, the most permanent at the bottom, the least permanent at the top. Create batch files to remove layers one at a time, several, or all of them at once.

And while other products gobble up to 40K, PopDrop needs just 1K!

PopDrop AND NEW—PopDrop Plus!

DB 2130 PopDrop PC-5¼ inch diskettes.....\$49.95
DB 2140 PopDrop PS/2-3½ inch diskettes.....\$49.95
DB 2150 PopDrop PLUS PC-5¼ AND 3½-inch.....\$99.95

PopDropPLUS vs. The Competition.

The memory requirements for five popular TSRs (SideKick, SuperKey, Turbo Lightning, SETUP2 and XDRI).

Task	PopDropPLUS	The Competition
Conventional Memory Used	27K	93K
Expanded memory used with 5 TSRs loaded	344K	508K
Disk space used for swap files for 5 TSRs	0	561K
Keyboard "slowdown"	No	Yes

Use Of Features	PopDropPLUS	The Competition
DOS commands to configure 10 TSRs	1	50
Number of TSRs per configuration list	50	32
Self removal supported	Yes	No

OPERATE ANY COMPUTER— ANYWHERE IN THE WORLD, BY REMOTE CONTROL.

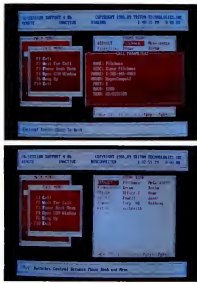
CO/SESSION Allows you to quickly connect your computer to a distant PC (on a phone line) and run that remote computer as if you were right there—at the keyboard! From a laptop in a hotel room, you can control your PC back at the office—even if it's more powerful—provide training, or troubleshoot a customer's PC (or software system) from your office. You can even print documents on either, or both systems simultaneously. And CO/SESSION 4.0 includes an all-new "windows-like" interface for speed and convenience, plus error-checking, seven advanced new security features, EGA, VGA and Hercules support (for graphics) and much more. The best package available for remote computing, remote customer support, background file transfers and remote network access. Easy to use—just install it—CO/SESSION sits in the background using only 51K.

And CO/SESSION transfers files up to **20 percent faster** than even its closest competitor—with screen updates over **400 percent faster!**

EXAMINE THE TREMENDOUS ADVANTAGES OF THIS EASY-TO-USE, CRITICALLY-ACCLAIMED REMOTE CONTROL PACKAGE

The future of computing hinges on the concept of connectivity. The ability to access computers from a remote location opens a world of productivity that until now, has been unimaginable.

CO/SESSION 4.0 runs in the background of both machines until called up by using hot keys. Both the remote (your computer) and host computer (the computer you're calling) can initiate calls using the convenient dialing directory. You'll control the distant PC with speed, safety and convenience. And CO/SESSION is fully compatible with all leading software like Lotus, WordStar, WordPerfect, dBASE IV, SideKick, Norton Utilities, etc. Imagine the time savings you'll enjoy working on your office PC—from your home! You can print documents, transfer files—even work together with an associate or customer—remotely!



"Windows-Like" Interface—with easy to use, pop-up menus.

PRINTING FEATURES

With CO/SESSION, printer output can be directed to the host and remote machine—simultaneously. The remote user may, if necessary, spool the output later printing.

VOICE DATA SWITCHING

Toggle back and forth between voice and data (using just ONE phone line), or start with a voice call, load CO/SESSION during the conversation, then switch directly to a CO/SESSION data connection. It also offers a COM port window—handy when setting up a non-Hayes modem. A "chat window" allows users to send and receive messages on-screen.

SMOOTH, FAST FILE TRANSFERS AND ERROR-CHECKING Copy data files in both directions—so you can work at home—without transferring diskettes!

And CO/SESSION's powerful error-checking capabilities allow you to call up your office PC and copy an entire APPLICATION FILE to your home computer!



CO/SESSION 4.0 \$199.95

A QUICK LOOK

CO/SESSION allows users to run a PC in a remote location—anywhere—via a modem, from their PC. Perfect for laptop users on the go who need to transfer data—even run applications while away. CO/SESSION is streamlined, simple to use with an all-new "windows-like" interface, unmatched speed, error-checking, convenience and security.

A Comparison of Background Functions

	CO-SESSION	Copy Copy	Goody	IN ANYTIME
Transfer Files	YES	YES	NO	NO
Change Directories	YES	NO	NO	NO
Display Directories	YES	NO	NO	NO
Display Files	YES	NO	NO	NO
Delete Files	YES	NO	NO	NO
Rename Files	YES	NO	NO	NO

CO/SESSION transfers files up to 20% faster—updates screens up to 400% faster than competitors!

In fact, CO/SESSION was proclaimed "Fastest Remote Software Package" by Infoworld in March, 1989!

ADVANCED SECURITY CO/SESSION protects your data with features like: dual-passwords, password-checking and data encryption. You can restrict the ability to send or receive files on the remote PC, blank the other computers' screen—even disable its keyboard to prevent unauthorized access. So if you're doing support on a remote PC, you can work in complete privacy—users or passers-by will not be able to see what you're doing. And CO/SESSION includes a "dial-back" feature that provides an additional level of security and reverses phone charges (for long-distance sessions) and unmatched error-checking for data safety.

"RECORD" REMOTE SESSIONS Record screen sequences within a session for playback later. You can even pause within a session and playback earlier transactions—great for training and system troubleshooting. The recorded information (including date, time, name and phone number) can be imported into a word processor for billing or documentation purposes.

CO/SESSION Remote Control Software From Tiger Software

DB 3800 CO/SESSION (2-user) IBM 5¼-inch.....\$199.95
DB 3805 CO/SESSION (2-user) PS/2 3½-inch.....\$199.95

Runs on the IBM PC, XT, AT, PS/2 and compatibles with 256K RAM (host PC requires only 50K). It will support virtually any dot matrix printer—as well as lasers.



GIVE YOUR PC XT THE POWER OF A 386!

A BREAKTHROUGH SOFTWARE PACKAGE—MAKES YOUR PC RUN UP TO 60 TIMES FASTER!

You read that right—up to 60 times faster! FAST! employs advanced speed enhancement techniques and brings them to a new, sophisticated level that delivers blazing speed to any program you run. And it's simple to use—just load it and go!

A Stock IBM XT vs. A Compaq 386! In our lab test, we matched a stock IBM PC XT, equipped with FAST!, against a stock Compaq DeskPro 386. The results were astounding—the XT outran the Compaq in a standard data transfer performance benchmark!

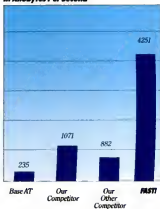
HOW IS IT POSSIBLE? FAST! incorporates the proven speed-enhancing performance of 'disk caching' and adds an innovative twist: FAST! includes a form of 'intuitive logic' that actually anticipates what data your CPU will be seeking, and reads that data from your fixed or floppy drive into a special RAM buffer (or 'cache')—BEFORE the CPU asks for it!

As a result, your CPU spends virtually no time at all waiting for disk reads—an inherent logjam that slows processing time significantly.

And using FAST!, you'll notice that the more disk-intensive the application (databases, for example), the more time FAST! will save—and the faster your applications will run.

And since FAST! reduces drive read time so drastically, it also reduces wear on the disk drive—extending its life.

Data Transfer Rates
In Kilobytes Per Second



On a standard data transfer performance test, FAST! is 18 times faster than a standard AT—and 5 times faster than the leading competitor. In fact, an IBM XT with FAST! is faster than a Compaq DeskPro 386!

DON'T BUY MORE EQUIPMENT! You could spend thousands of dollars trying to achieve the speed required for truly efficient computing. Items like high-speed drives, turbos boards—even complete system upgrades try to overcome your system's inherent slowdown—waiting for disk reads.

FAST! is the only product that eliminates this processing tie-up and gives you top performance—using only 8K—for just \$99.95.

And FAST! will work with conventional, extended, or expanded RAM.

IMAGINE WHAT FAST! CAN DO FOR A 386! FAST! will deliver spectacular results on your IBM PC, XT, AT and PS/2, but imagine how much faster the "new generation" of ultra high-speed processing technology like the Compaq 386 or Intel's 386 Above Board will run using FAST!—they instantly leap into a new computing class!

In addition, FAST! supports 'hot key' controls for instant response and allows most operating parameters to be altered any time after installation—saving even more time and allowing you to be more productive. FAST! supports EXPANDED memory—but it is not required!

WE SHIP YOUR ORDER SAME-DAY VIA FEDERAL EXPRESS!

GIVE YOUR
PC XT
EXPLOSIVE 386-
SPEED

FAST! \$99.95

A QUICK LOOK

✓ FAST! is an advanced, simple-to-use disk performance utility that employs a new concept in disk caching to achieve a dramatic increase in processing speed—in fact, your applications will run anywhere from 5 to 60 times faster! And FAST! requires no additional hardware.

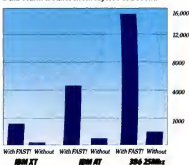
✓ This method also reduces wear on your drive since continuous disk reading is virtually non-existent, your drives will last longer and run faster than you ever dreamed possible—using about 8K.

✓ FAST! is extremely easy to use, requiring just a simple installation. Its user-definable 'hot keys' will enhance performance even more.

✓ Compatibility-tested with over 650 applications.

With FAST! vs. Without FAST!

Data Transfer Rates In Kilobytes Per Second



FAST! Disk Performance Utility

DB 3850 FAST!—IBM 5 1/4 inch.....\$99.95
DB 3855 FAST!—PS/2 3 1/2 inch.....\$99.95

FAST! will run on the IBM PC, XT, AT, PS/2 and compatibles with 128K RAM and DOS 2.1 or greater. Supports fixed or floppy disk systems, and supports conventional, expanded or extended memory.



CALL TOLL-FREE (800) 888-4437

THE BEST SELLING FORMS PACKAGE IN THE WORLD!

The Fastest, Easiest Way To Create Any Form!

"...Its simple, clean design makes it quick to learn and use...We were able to draw our purchase order form in just 6 minutes. Lines and boxes are very easy to draw and erase!"

—PC MAGAZINE



The perfect tool for fast information gathering!

Throw away those generic form books, expensive typesetting invoices and printing headaches. With FORMTOOL, you can create, edit, manage, and print any form—from postage stamp size up to 13 inches quickly and easily on your PC, XT, AT or PS/2. And it's so easy! You draw lines and boxes by simply moving the cursor—and FORMTOOL is compatible with virtually all dot matrix, letter quality and laser printers. Produce your own invoices, purchase orders, shipping documents, employee time sheets, evaluation forms, estimate forms—hundreds of uses!

And FormTool will print forms sideways, adjustment of line and character spacing—even print math symbols.

FormTool was designed to meet an urgent need of the business environment: provide a low-cost means by which users can quickly and easily create their own forms using virtually any equipment—Just sit down and create a form.

Draw Lines, Boxes And Grids—in Seconds

FormTool streamlines the PC's ability to draw—lines, boxes and grids are drawn for you with just a couple of keystrokes. You can change your grid layout, adjust type sizes, rearrange boxes—in seconds!

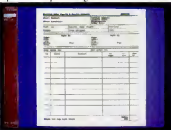
An advanced word processor handles word and character wrapping, custom "FastTabs," and the ability to automatically fit text into a defined area—or quickly reformat if necessary.

"THE FORMTOOL FORMS DESIGN KIT." FormTool includes over 120 pre-designed forms ready to use—or modify them to fit your particular needs. Plus, a guide to forms design by forms expert Michael J. McCrory.



INCLUDES FULL-PAGE WYSIWYG PREVIEW!

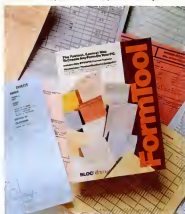
Preview your forms—full-page—with our new WYSIWYG preview capability. Spot errors in spacing, layout, type and alignment before committing the form to paper. This new feature provides the WYSIWYG advantages of graphics-based products with the blistering speed of text processing.



See your form on the screen—as it will print!

FormTool From Tiger

DB 1010 FormTool 3 1/2" PS/2\$95.00
DB 1020 FormTool 5 1/4" PCCompatible\$95.00
IBM PC, PS/2, compatible with 256K memory. Floppy or hard disk, supports all color or monochrome monitors with or without graphics card and virtually all dot matrix, daisywheel and laser printers.



ANATOMY OF A FORMTOOL FORM

Horizontal And Vertical Line Drawing

All you have to do is position the cursor where you want to draw a line. Then hit one key, and FormTool will automatically draw the line.

Perfect Corners

FormTool will end every line with perfect corners and T's, every time. It will even pipe double lines.

Line Width

Just specify single, double, or bold lines, and FormTool will draw them. You can also switch between single, double and bold lines with one keystroke.

Automatic Grid Drawing

Drawing a grid is as easy. Just specify:

*Column width *Number of columns
*Row height *Number of rows

Or leave any out, and FormTool will automatically draw the grid based on your specifications.

Large Letters

You can select large letters, and even oversize letters up to one inch tall.

Variable Type Sizes

Variable sizes, and styles are available, and are selected from an easy-to-follow menu.

Special Characters

Special characters like this box, as well as math symbols and graphic characters are available.

WYSIWYG And Double Lines

And they'll end in the right place.

Variable Spacing

Specify variable line spacing of 6, 8, or 10 lines per inch and character spacing of 10, 12, 15, or 17 characters per inch, from FormTool's menu.

SERVICE REPORT

Call Date: _____ Support By: _____ DB # _____ Call Result: _____
 Time Start: _____ Time End: _____ Phone: _____
 Customer: _____ Company: _____
 Product Version: 1.0 1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 1.9 2.0 2.1 2.2 registration fee _____
 Reason: ☐ Product info ☐ Service Product Design ☐ Product Problem ☐ Product Defect ☐ Other reason _____
 Date: _____ Program: ☐ Printing ☐ Size: _____ Color: _____ Resolution: _____
PRINTING RELATED PROBLEMS
 Printer Brand: _____ Printer Model: _____
 Name: _____
 Program Port Selection: ☐ COM1 ☐ COM2 ☐ LPT1 ☐ LPT2 ☐ LPT3 ☐ Parallel ☐
 Actual Port Selection: ☐ COM1 ☐ COM2 ☐ LPT1 ☐ LPT2 ☐ LPT3 ☐ Parallel ☐
 Software Print Speed: ☐ YES ☐ NO ☐
 Printer Switch Settings: _____
SYSTEM RELATED PROBLEMS
 Computer Brand: _____
 Computer Model: _____
 CPU Version: _____
 RAM Memory: _____
 Hard Disk: _____
 CPU Speed: _____
 Display: _____
 Mouse: _____
 Keyboard: _____
USER CHANGES MADE TO PRINT DRIVERS

Even the most complex forms can be created in just minutes!

TO ORDER, CALL TOLL-FREE: (800) 888-4437

If You Use LARGE Spreadsheets, Document Files Or TSRs—Don't Buy An "AboveBoard", Get "AboveDISC!"

GET UP TO 32Mb OF EXPANDED MEMORY—WITHOUT BUYING ANY HARDWARE!

AboveDISC 3.0. Convert Extended Memory And Hard Disk Space Into Expanded Memory—For Just \$99.95!

BREAK THE 640K BARRIER with AboveDISC Now you can run memory-hungry applications like large spreadsheets, large desktop publishing and text files, Windows, "new-generation" TSRs—even more sophisticated CAD drawings—**without buying any new hardware—saves expansion slots!** It's ideal for laptops.

AboveDISC actually utilizes previously unused portions of your Extended Memory located on the motherboard—**OR employs your hard disk—to simulate EXPANDED Memory.** It accesses up to 32 megabytes of paged memory and supports EMS 3.2 and 4.0.

You could spend \$1000 for just ONE MEGABYTE of Expanded Memory—or you could buy AboveDISC—**and get up to 32 MEGS**—for just **\$99.95!** If you use a PS/2 with 1 or 2 megabytes of Extended memory, and want to fully utilize it—or if you're on a network (like 3Com) and have problems using menuing or accessing programs, or if you'd like to increase the RAM capacity of your current PCs, XT's and AT's—AboveDISC is the ideal, **inexpensive solution** (without sacrificing precious expansion slots). Installs in seconds.

AboveDISC TURNS YOUR HARD DISK INTO EXPANDED MEMORY!

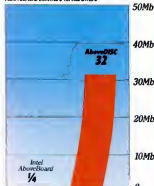
AboveDISC seeks out all the memory available on the motherboard beyond 640K, all the RAM on your extended memory board (much of it completely unused), or up to 32Mb of memory on your hard disk and uses it to simulate expanded memory. So you'll use memory you simply never had before—to run faster, more powerful applications and create larger spreadsheets, drawings or databases.

WHY PAY THE ASTRONOMICAL PRICE OF MEMORY BOARDS?

...When for just \$99.95, you can simulate Expanded Memory—and get the same fast, smooth performance. Here's a comparison of AboveDISC software vs. hardware.

MEGABYTES PER 100 DOLLARS

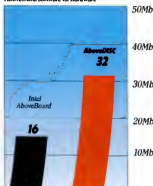
AboveDISC software vs. hardware



You'd spend up to \$1000 to equip your system with Intel's AboveBoard—and get 1/4 meg of Expanded Memory per \$100, vs AboveDISC's 32!

POTENTIAL CAPACITY

AboveDISC software vs. hardware



With the Intel board, you're limited to 16Mb of Expanded Memory. With AboveDISC, you can gain up to 32 and use the larger programs!

AboveDISC 3.1 \$99.95

A QUICK LOOK

- Beyond the restrictions of conventional memory lies faster, more powerful programs—but the cost of expanded memory is prohibitive.
- AboveDISC finds unused memory within your system, and utilizes your hard disk to simulate expanded memory—up to 32 megs!
- Installs in seconds, runs on any IBM-compatible computer. Saves precious expansion slots. Ideal laptop accessory.
- Supports LIM 4.0 and 3.2 standards.

HOW ABOUT COMPATIBILITY? AboveDISC is fully compatible with: Lotus 1-2-3, Symphony, EXCEL, Windows, Paradox, Quattro, Reflex, AutoCAD, Framework II, PageMaker and more, call us for compatibility details.

And AboveDISC is transparent, so if your machine runs at 25Mhz, so does AboveDISC!

So before you retire your extended memory card or junk the non-expandable machine, try AboveDISC—and save a bundle!

Simulate Expanded Memory!



AboveDISC

Expanded Memory Simulator

DB6550 AboveDISC IBM 5¼ AND 3½ inch.....\$99.95

Runs on IBM PC, XT, AT, PS/2 and compatibles. Requires 256K memory. Uses as little as 14K of lower 640K memory.

WE'LL SHIP YOUR ORDER SAME-DAY VIA FEDERAL EXPRESS!**CALL (800) 88-TIGER**

STOP WAITING (...AND WAITING) FOR YOUR PRINTER!

Now You Can Run Your Printer—While Working (at top speed) On Your PC.

PrintRite allows users to run print jobs of any size—while continuing to work, at top speed, on your computer. PrintRite spools your print jobs to disk (and compresses them), allowing applications to generate print jobs at maximum speed—and save hours of printing time—and it occupies less than 50K memory. Spend time working—not waiting for print jobs!

DESIGNED FOR FAST, EFFICIENT OPERATION Stop wasting time waiting for your printer to finish a document so you can continue to work on your PC. Harness the power of professional mainframe spooling technology—in an easy to use package.

Introducing PrintRite. Designed for fast, efficient operation, its streamlined pull-down menus allow you to print documents, lists, labels, spreadsheets—anything—while you continue to work, uninterrupted, on your PC.

PrintRite compresses spooled files to disk for ultra-efficient use of memory. PrintRite spools each file separately (rather than in one large file) to eliminate costly hard-disk fragmentation. And only PrintRite allows you to control five printers at one time, so you can dedicate specific printers for certain tasks. Pop PrintRite up anytime and view the queue and documents on-line. Change the printing order, specify the number of copies, sideways printing, add items—even pause and restart.

FORMS ALIGNMENT, MULTIPLE PRINTER SUPPORT PrintRite will prompt you for alignment of the first page, or every page of your documents.

Re-run reports at any page, and stop or start a print job at any time if you need silence.



Control up to five different printers—switch between printers and jobs on a per document basis—automatically—while you work on something else.

GROUPS SIMILAR PRINT JOBS FOR MAXIMUM EFFICIENCY PrintRite automatically groups types of printing jobs together (like spreadsheets, text, graphics and sideways jobs) for more efficient use of the equipment.

Spooled files are compressed to save disk space and prevent loss of data that can occur with other memory print buffers. PrintRite guarantees 100 percent protection of every bit of your data—even in the event of a power loss with its auto-backup.

NOW LAPTOP USERS CAN PRINT—WITHOUT A PRINTER To your laptop computer, PrintRite looks like a printer. Your print jobs are spooled to disk and stored (compressed) in a DOS file. When you get to a printer, PrintRite will print the documents.



PrintRite's easy-to-use pull down menus allow fast, easy operation. The handy view screen (shown here) displays the printing order of your documents. From this screen, you can quickly re-arrange the order in which your jobs will be printed—even stop or restart.

PrintRite gives you more control with less work. And that means increased productivity!

THE PROFESSIONAL STRENGTH PRINT SPOOLER.

PrintRite \$99.95

A QUICK LOOK

- ✓ PrintRite is an easy-to-use utility that allows you to continue working on your computer—while printing! Laptop users who create or edit documents away from the office can store them—ready-to-print—until they get back to their printer.
- ✓ PrintRite is RAM-resident, allowing pop-up-anytime status checks on your print job, and requires less than 50K.
- ✓ PrintRite monitors all printer activity and intercepts printer output, spools it (compressed) to a DOS file. It is then added to your print queue—affording you complete control.
- ✓ PrintRite will add text files directly to queue—without spooling, to save time and valuable disk space. You can hold reports in queue until they're needed—and switch automatically between up to five printers. PrintRite supports LANs and printer networks, and will print up to 65,535 copies!

PrintRite

Printer Management Toolkit From Tiger Software

DB 4960 PrintRite IBM 5¼ AND 3½ inch.....\$99.95

Runs on IBM PC, XT, AT, PS/2 and compatibles. Requires 50K memory. Will support virtually any printer.



WHEN YOU MUST FILL-IN A **PRE-PRINTED** FORM...

A Complete System For Quickly And Accurately Filling In Any Form On Any PC And Printer.

Are you still trying to fill-in pre-printed forms like insurance claims, contracts, invoices, loan applications, purchase orders, requisitions, shipping forms—using a typewriter or word processor?

As you've no doubt discovered, most forms don't use any standard spacing at all—so your typewriter, word processor or spreadsheet simply can't do the job accurately or efficiently. In fact, it's an incredible waste of time—and the margin for error is high.

FormFiller allows easy, fast fill-in of any form, using virtually any PC and printer—regardless of the form's spacing or complexity—and you don't need a graphics adapter or color monitor.

FormFiller locates blanks on your form by printing a "grid" directly on the form. From this grid, FormFiller automatically creates a "master template" and sets up fields for each blank on the form—you can simply tab from one blank to the next.

This is the **ONLY** system that completely synchronizes your computer and printer—using this "template" concept for fast, accurate fill-in of any pre-printed form!

And FormFiller is the only system that allows fill-in of double-sided, multi-part, or interleaved carbon forms.

FormFiller's precise fill-in capabilities, along with its math, database and importing features makes it the premiere forms processing package available today.



FormFiller 2.0 Named "Best Buy"

PC WORLD magazine named FormFiller 2.0 "Best Buy" in forms processing software for 1989.

ALL-NEW!
VERSION 2.0
INCLUDES SAMPLE
TEMPLATES—READY TO USE!
FREE!

FormFiller 2.0 \$149

A QUICK LOOK

- **Easy To Use** Version 2's streamlined, "word-processor-like" feel is perfect for both novice and advanced users.
- **Fill-In Any Form** With FormFiller's unique grid "design," you can quickly match the spacing of any form to achieve pinpoint-precision. And FormFiller will support up to 640 fields!
- **Powerful Import Capabilities** FormFiller will allow you to "swap" data with your favorite spreadsheet or database, eliminating double entry. You can also import/merge/export any DIF, dBASE II, III, Lotus 1-2-3 (WKS and WK1) or ASCII files.
- **Ingenious "Look-up" Feature** FormFiller can actually look up details (like part numbers and prices) for you—and fill them automatically into position on the form.
- **Powerful Math Functions** Built-in spreadsheet functions that automatically fill-in calculated values. It even checks the forms for errors and omissions.

FAST AND EASY FORM FILL-IN By taking the repetitive, tedious work out of form fill-in, FormFiller enhances accuracy and greatly increases speed. Data can be stored within the template—and printed automatically! Call it up, make necessary changes, and print the entire form again.

PINPOINT-PRECISE SPACING FormFiller has the flexibility to match any spacing of blanks on your forms—it allows each field to be individually adjusted, if necessary, by increments of 1/700th of an inch—so every "X" will appear in the proper box—not below or beside it.

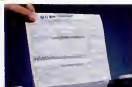
SPREADSHEET-LIKE FINANCIAL AND MATH FUNCTIONS FormFiller's powerful math and financial functions will calculate figures and fill them in for you—automatically!

FormFiller can add the numbers in specified fields, deduct a specified discount, and print the total in a specified field. Fill-in data can be stored for later recall and fill-in. Change one number, and FormFiller will automatically re-calculate the numbers and enter them into proper position on the form.

Calculate percentages, loan and amortization figures, depreciation, present and future values—dozens more.

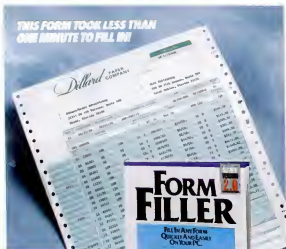
Government Forms Business Forms...

FormFiller can fill-in federal, state and local government forms, legal and tax forms, medical and insurance forms, loan, mortgage, and other financial forms.



FormFiller 2.0 And FREE FormFiller Sampler!

DB 8002 IBM PC-compatible 5¼"\$149
DB 8120 PS/2 3½" inch Diskettes\$149
IBM PC, XT, AT, PS/2 or compatible with 512K, DOS 2.0 or greater and 2 floppy drives, or one floppy drive and a hard disk. Supports virtually all printers.
Includes "The FormFiller Sampler"—sample templates, User guide and spacing grid.



Fill-In Any Form Regardless Of Its Complexity!

FormFiller 2.0 has become the corporate standard...



FREE FEDERAL EXPRESS! CALL TOLL-FREE (800) 888-4437 TO ORDER

The High Performance Mail And Customer List Manager—Just \$79.95!

More Power And Features Than Other Packages Costing TEN TIMES As Much!

Keep in touch with customers, contacts, prospects and associates.

FastPak Mail is the ready-to-use package that gives users of any expertise level the ability to completely automate their entire mail preparation process. It automatically eliminates duplicates, performs professional mail-merge, handles bulk mailings—quickly and easily.

Prints your customized letters, envelopes, post cards, name tags, shipping labels, clear labels, rotary index cards, continuous envelopes, C.O.D. labels—plus hundreds more!

Use your existing information. You can quickly insert names, addresses, and customized messages into the body of your letters using FastPak Mail to import information from programs like dBASE for timely, efficient mailings.

Small or large mailings!

FastPak Mail takes the guesswork out of mailing—even sorts bulk mail for lowest possible postage rates.

Newsletters, direct mail campaigns, fund-raising, follow-up, prospecting, questionnaires, holidays, special events—any mailing task!

READY-TO-PRINT LISTS AND LABELS Print labels 1, 2, 3 or 4 across, clear labels, rotary index cards, file folder labels, packing labels, name tags, post cards, envelopes, invoices, 3 x 5 index cards, cassette labels—and dozens more!

FIRST, EASY BULK MAILING

FEATURES Easy to use bulk rate sorting, indexing and labelling—FastPak Mail will automatically eliminate any duplicates in your list and sort your bulk mailings by 9, 5, or 3-digits—for postage savings up to 25%!

MERGE NAMES AND ADDRESSES

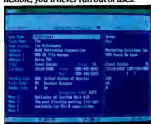
INTO YOUR LETTERS Convert any list that you have (from dBASE, Lotus, or any ASCII file) and merge that information (names, addresses, etc.) into the body of your letters. Everything you mail will be clean and professional-looking. And FastPak Mail is compatible with virtually any program—eliminating data re-entry!

Use FastPak Mail to customize proposals, reports, letters, notices, statements, invitations, follow-up notes and press releases.

PERFECT FOR PERSONAL OR BUSINESS MAILINGS!

FastPak Mail contains hundreds of pre-defined formats for any mailing task—it's so simple to set up and use that you'll be organizing and printing lists minutes after opening the box!

FastPak Mail is so feature-rich (with it's mini database and word processor) and flexible, you'll never run out of uses.



Two Keystrokes...

Pops-up the FastPak menu to add a name to your list.

Create labels by selecting from hundreds of pre-defined formats.

Give FastPak Mail a zip code, and it will automatically look up the City, State and area code!

Includes fast, easy importing features—you can use any of your existing data in FastPak Mail—eliminating re-entry of data!



FastPak Mail \$79.95

A QUICK LOOK

FastPak Mail is a complete mail preparation system that combines mail and customer list management into a simple-to-use package.

There are hundreds of built-in label formats, making FastPak Mail ready to go out of the box.

Also includes easy importing, so any existing list can be utilized for professional mail merge.

Awarded PC magazine's "Editor's Choice."

A Great DIRECT MAIL Tool! FastPak Mail contains features found in large direct mail systems—in a friendlier, simplified format.

Staying in front of your list of customers and potential customers with a company newsletter is perhaps one of the most effective ways for you to build awareness.

MANAGE YOUR MAIL LIST WITH FASTPAK MAIL!

DB 4550 FastPak Mail IBM PC 5¼ inch.....\$79.95

DB 4555 FastPak Mail PS/2 —3½ inch.....\$79.95

IBM PC, XT, AT, PS/2 and compatibles with 256K. Supports hundreds of dot matrix or laser printers.



READ THIS CAREFULLY IF YOU OWN A HARD DISK.

YOUR HARD DISK IS A TIME BOMB!

Fragmentation is inevitable and fatal! When your hard disk was new, it ran lean and swift, retrieving files in just a few seconds. But as you added files and programs to it, your hard disk became fat and sluggish—in fact, a fragmented, "dirty" hard disk can take up to 100 seconds to retrieve a file that used to take just 10 seconds—TEN TIMES SLOWER!

The problem? Fragmentation kills hard disk performance. It causes excessive head movement across the media, creating bad spots throughout the drive. It's aggravating—and it's dangerous! A fragmented hard disk, left unmaintained, is almost certain to crash. That means major data loss. **DISK OPTIMIZER 4.0** is the standard for hard disk optimization software. Its sleek, easy-to-use menu system makes hard disk maintenance simple.

1. The New Hard Disk.

This is a new brand new hard disk. As you begin to create files, they are stored on the disk randomly. Each occupies a place on the sparsely-populated disk. At this point, disk performance is at its peak. A 256K file or program can be retrieved in just a few seconds. Wear and tear on your equipment is minimal.

2. Fragmentation Begins.

As you edit these existing files, DOS will store your additional data in the same random manner. If you delete a file, a "hole" is left where that file had been stored. DOS will fill that hole with parts of other files. Fragmentation has begun. Your hard disk is running considerably slower.

More and more files are added, edited and deleted. There are places of your files and programs scattered all over the disk. Your hard disk's head spends more time "drugging" across the surface of the disk, endangering the media—and the data.

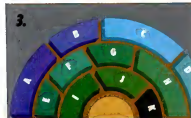
Under these conditions, the risk of a hard disk crash is high, and the wear and tear on your disk's moving parts and magnetic media is severe. And it's slower than ever!

3. After Using Disk Optimizer.

DISK OPTIMIZER assembles the pieces of your fragmented files and stores them as **ONE FILE**. Just a couple of keystrokes will help your hard disk run up to 300 percent faster! And all of your data is 100% safe. Your hard disk and your data are safe.

DISK OPTIMIZER contains features such as "Data Guardian," that can recover files and reformat accidentally formatted hard disks—plus a dozen new utility features.

Over 250,000 users have discovered that **Disk Optimizer** saves time and money, while providing complete protection from hard disk errors and crashes.



Disk Optimizer 4.0
And **FREE CUBIT** a \$69.95 Value
Just \$69.95

A QUICK LOOK

- ✓ Restores speed to your hard disk by eliminating fragmentation of your files and programs. Can increase speed up to 300% and minimize wear on the hard disk. Installs in seconds.
- ✓ Reduces the risk of hard disk failure. A fragmented hard disk will almost certainly crash at some point.
- ✓ Contains data and disk recovery features with its "Data Guardian." Undelete deleted files—even restore accidentally formatted hard disks.
- ✓ Contains 17 easy-to-use utilities.

MAINTENANCE FEATURES:

TrackSaver Protects the surface of your disk from excessive wear by preventing the head of the drive from spinning over the same track for too long.

Refresh Prevents bad spots that develop on disks due to fading magnetic charges.

Advanced New "Data Guardian" Instantly restores an accidentally deleted file, directory or hard disk—up to 255 days after it was erased! Accidentally format your hard disk? Just select Data Guardian's UNFORMAT feature and it's instantly restored!

Analyze Graphical displays show you how much fragmentation has taken place on your hard disk.

Wipefile Completely delete sensitive files to prevent unauthorized access.

Findfile and FilePeak Misplace a file? Findfile will perform a "wildcard" search with just a couple of keystrokes. Then get a "quick look" with FilePeak.



DISK OPTIMIZER 4.0
AND **FREE "CUBIT"**

DB 3280 Disk Optimizer 4.0—IBM 5¼ inch...\$69.95
DB 3285 Disk Optimizer 4.0—PS/2 3½ inch...\$69.95
Runs on IBM PC and compatibles. Supports DOS 4.0.

FREE! WITH DISK OPTIMIZER: 'CUBIT' COMPRESSION UTILITY.

CUBIT safely compresses the data stored on your hard disk up to 70 percent. When a file is called, the data is automatically de-compressed. If your hard disk is nearly full, **CUBIT** can save you the cost of a new one by compressing your files—by up to 75 percent!



A
\$69.95
Value!

FREE CUBIT WITH DISK OPTIMIZER

FREE SAME-DAY FEDERAL EXPRESS SHIPPING

CREATE BINDING LEGAL DOCUMENTS ON ANY PC!

Software That 'Writes' Wills, Leases, Promissory Notes, And Other Binding Documents.



An easy-to-use, on-screen 'interview' format! Now you can produce binding legal documents for everyday legal situations without hiring an attorney. **PERSONAL LAWYER** will handle: **General Power Of Attorney, Special Power Of Attorney, Revocation Of Power Of Attorney, Statement Of Child Guardianship, Residential Real Estate lease, Promissory Note and Personal Wills.**

PERSONAL LAWYER works by asking you a set of questions related to your specific situation. The program will then ask subsequent questions, to follow-up, based on your original responses. Once the complete set of questions has been answered, **PERSONAL LAWYER** will compile the information, select paragraphs from a predetermined set within the system, and actually "write" an enforceable document for the circumstances you've described using its unique "text-builder".

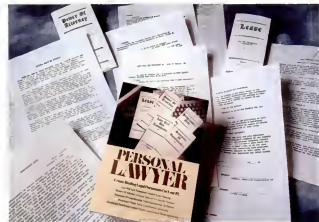
This program has been developed under the supervision of attorney Douglas B. Jacobs, and the documents produced are legally binding. You could save thousands of dollars in legal fees by preparing documents yourself quickly, easily—and inexpensively—with **PERSONAL LAWYER**.

[The **PERSONAL LAWYER** meets the requirements of 49 states and the District of Columbia—the state of Louisiana is excluded because much of its legal system is based on French rather than English law.]

LAST WILL AND TESTAMENT. The importance of a personal will cannot be overstated and there are many reasons for having a will in today's society.

Without some careful thought to the distribution of your estate, it is possible that it might escheat (default) to the State or Federal Government, resulting in higher taxes and/or fees than necessary.

Personal Lawyer permits you to bequeath general or special gifts. It also enables you to specify the executor of your estate, choose a guardian or guardians to care for minor children and make many other decisions for competent estate planning.



Personal Lawyer \$59.95

A QUICK LOOK

- ✓ Fast, easy-to-use system that allows you to produce binding documents for everyday legal situations.
- ✓ Handy tool for quickly updating your will, lending money, leaving your child in the care of others—even producing a residential lease.
- ✓ Just type answers to questions asked by the system and the document is written for you.



Simply type the answers to questions that appear on-screen. **Personal Lawyer** then "writes" the document for you.

PROMISSORY NOTE Promissory notes provide the written ability to agree to accept a loan on certain terms and to define the payback of the loan.

POWER OF ATTORNEY Power of attorney documents give you the power to take care of your assets, either generally, or for specific matters.

STATEMENT OF GUARDIANSHIP A Statement of Guardianship is used to appoint someone to handle the personal rights of your children in a temporary situation.

RESIDENTIAL REAL ESTATE LEASE This portion of the program allows you to easily write a legally binding lease for such residential property as a house, duplex, apartment or rental condominium.

If you have real property to rent as a residence, or you are a renter of such property, you need the protection of a **written lease**.

Create a lease that covers such items as: security deposits, pets, payment of utilities, parking, etc.

Personal Lawyer From Tiger Software

DB 2250 Personal Lawyer 5¼ Diskettes\$59.95
DB 2255 Personal Lawyer 3½ Diskettes\$59.95
Requires minimum 256K RAM. Supports color or monochrome and fully supports virtually ALL printers.

WE SHIP FREE—VIA FEDERAL EXPRESS!

CALL US TOLL-FREE AT (800) 888-4437

We've Carefully Assembled The Tiger "Dream System."

The Perfect System For Home, Office And Education!

Includes Hardware, Mouse And Software Library—Plug It In And Go!

For a while now, our customers have been asking our advice on which system they should buy. They ask about starter systems for home or a good second computer for their expanding businesses. So, we looked around. We looked at equipment from virtually every leading manufacturer and what caught our eye was the system you see here. The HeadStart EX-938 S-1 Explorer.

HERE'S WHAT YOU GET: The instantly expandable Explorer packs an ultra-fast 8088-1 9.54 / 4.77 MHz microprocessor, color monitor with stand, full-function 84-key keyboard, a mouse and plug-in ports for a joystick, a modem, a printer, color or monochrome displays and extra memory. You also get a hand-picked assortment of software including the Splash! Jr. paint program and more for use with the sleek, 3-button mouse! And the entire package is backed 100 percent for 12 months by HeadStart. When you're ready to expand the system, just "plug-in" the optional 40 meg hard drive!

This system is built by one of the emerging leaders in technology for the 1990s and beyond—North American Philips.

- ✓ 8088-1 processor (9.54 or 4.77) MHz
- ✓ Co-processor socket for 8087
- ✓ 3 1/4" 720K Disk Drive
- ✓ 3-Button Mouse
- ✓ 512K Memory, expandable to 768K
- ✓ 384K bytes of custom ROM
- ✓ HeadStart BIOS
- ✓ Built-in CGA, Extended 16-color CGA, MDA and Hercules™ Video Graphic
- ✓ Built-In "Flip-Down" 84-Key, "AT" Style Keyboard
- ✓ Built-In Clock, Calendar And Phone Book
- ✓ Built-In Word Processor
- ✓ Serial & Parallel Ports
- ✓ 5 1/4" Floppy Interface
- ✓ Hard Disk Interface Built Onto Motherboard
- ✓ Built-In Calculator, Datebook, Spell Checker—and streamlined, "graphical" user interface
- ✓ "File Cabinet" For Organizing Lists
- ✓ 12-Month Warranty On Parts/Labor

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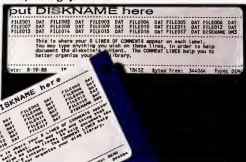
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20/20 PORTABLE 386s

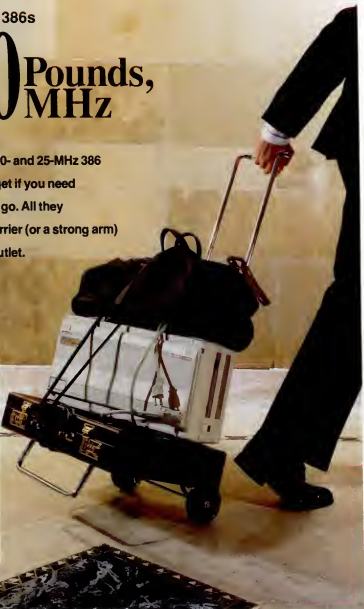
Over 20 Pounds, Over 20 MHz

They're not too easy to lug around, but these 20- and 25-MHz 386 lunchboxes are on target if you need your desktop power to go. All they require is a luggage carrier (or a strong arm) and access to an AC outlet.

by Bill Howard

Bor-ing! That will be your first impression when confronted by the dozen cookie-cutter machines that make up the high end of the portable PC marketplace. With just a few exceptions, the shells housing high-end 386 portables appear to be knock-offs of the cases fabricated for the Compaq Portable 386 and Portable III.

Inside, it's a somewhat different story, with a fair variety of design, power, and performance characteristics



PHOTOGRAPH: THOM O'CONNOR

that distinguish this field from the original. Dataquest, a San Jose market research firm, predicts further change in this form factor, stating that the promise of the i486 processor and color portables will fuel growth in the transportable PC market. While high-end portables currently hold less than 5 percent of the DOS-to-travel market now, these improvements are expected to improve the percentages.

Over the past several years, *PC Magazine* has reviewed laptops, portables, and transportables. Most recently, we reviewed 286 battery-powered portables (see "286 Laptops Compute en Route," *PC Magazine*, July 1989) and 8086/8088 battery-powered portables ("Lightweight Laptops," October 17, 1989). In this issue, *PC Magazine* examines ten AC-powered transportables with 80386 processors running at 20 or 25 MHz. They're from Compaq, IBM, Toshiba, and seven somewhat less well-known companies: Dolch, Micro Express, Micro Telesis, National Micro Systems, Pan United, PC Brand, and Tangent. Kiss Computer Corp. sent us several of its Kiss Lunchbox LX386M85s, but they proved unreadly for market.

Based on the results of benchmark tests run at PC Labs, informal poking and prodding, and the hands-on observations of our authors, we believe that this group of transportables—386 power platforms with handles—is somewhat immature. First, some of the major players have not yet arrived at the party, most noticeably Zenith and GRiD Systems, whose best efforts stop at 12.5 MHz, and NEC, which goes up to 16 MHz. More importantly, we believe the majority of the ten transportables we tested lack the fit and finish you deserve from \$5,000-plus computers, especially in cases where hinged flaps move stiffly, securing latches don't lock securely, and sliding display panels refuse to stay up or down. To their credit, Compaq, Dolch, IBM, and Toshiba are comparatively immune to these cosmetic quality-control problems.

Whose machines are the copycats? Externally, the Tangent and Micro Express units are identical to each other and almost indistinguishable from the Compaq, PC Brand, Micro Telesis, and National Micro Systems are similar and also hard to distin-

For the features section of this issue, the associate editor was Kellyn Betts and the PC Labs project leader was Robert W. Kane.

HOW TO STUFF A WILD LAPTOP: Portable Computer Expansion

by Bruce Brown

Portability demands making trade-offs. Traditionally, to get smaller size and weight you are forced to give up comfort, convenience, or power. But since these 20-plus-pound, AC-only, 386-based portables score low on both the comfort and the convenience scales—and cost anywhere from \$3,000 to over \$12,000—you won't be willing to sacrifice much in terms of power.

With this batch of portables, the loss of expandability is one concession you don't have to make. All of the 386-based portable computers that we reviewed can be expanded to some de-

tional monitors plugged into them. Some provide DB-9 connectors for CGA or EGA, some provide DB-15 pin connectors for VGA, and some provide both. Of course you're stuck with the resolution generated by the adapter inside the portable—no higher than EGA in many of these machines—unless you purchase a higher-resolution card, which means you need an extra slot available to plug it into. The only exception to this rule is the PC Brand 386/25 VGA Portable III. Its internal VGA adapter has a feature connector that allows you to attach a higher-resolution adapter to it (through the use of a



As the first Micro Channel transportable, the IBM PS/2 Model P70 386 breaks new ground. The Model P70 sports a full-length 32-bit expansion slot on top and a half-length 16-bit slot below, the latter sized for IBM's internal 2,400-bit-per-second MCA modem. The connections for expansion cards as well as parallel, serial, mouse, and external VGA ports can be accessed behind a hinged opening at the back of the Model P70.

gree. In this context, *expandability* means more than merely being able to insert a few empty slots for your modem or extra memory.

Since these machines are powerful and expensive enough that many people purchase them to perform desktop as well as portable computing functions, it means being able to add the equipment you need to optimize desktop performance.

All of these portables can have ex-

ternal monitors plugged into them. Some provide DB-9 connectors for CGA or EGA, some provide DB-15 pin connectors for VGA, and some provide both. Of course you're stuck with the resolution generated by the adapter inside the portable—no higher than EGA in many of these machines—unless you purchase a higher-resolution card, which means you need an extra slot available to plug it into. The only exception to this rule is the PC Brand 386/25 VGA Portable III. Its internal VGA adapter has a feature connector that allows you to attach a higher-resolution adapter to it (through the use of a

ribbon cable); thus a top-quality monitor can display both VGA and whatever mode is generated by the additional card.

Since the IBM PS/2 Model P70 386 is the only machine to come equipped with a full-sized Enhanced keyboard, most of these portables let you connect an external keyboard. Most allow you to add an extra floppy disk drive or two (if you don't mind the extra weight), and several have ports for external flopp-

py disk drives (which are sold separately). Each of the computers comes with one parallel port and one serial port; some include a second serial port and a game port.

RAM CRAM

The memory of all of these portables can be upgraded either by adding standard DIP/SIMM memory or by using proprietary memory modules. Most units provide up to 8MB of 32-bit memory on the motherboard or a proprietary memory card. Because it is an MCA machine, IBM's PS/2 Model P70 comes only with MCA expansion

slot (though the modems required usually carry a premium price).

The Toshiba, Compaq, and Dolch portables all offer optional external expansion boxes, but the external units for these machines let you add only slots. Since many of these machines are used both on the desktop and on the road, other powerful portables provide bigger boxes that may let you leave printers, displays, and keyboards permanently hooked up, in addition to accommodating one or more extra drives and up to five expansion interface cards. The NEC ProSpeed 386—not reviewed because it is only a 16-MHz ma-

guish from a Compaq. All five are chunky beige boxes with drop-down keyboards, plasma displays that swing out and up, and access to expansion cards on the top-left side. The Dolch's gray case is of a somewhat different design, but the only truly different machines are the IBM PS/2 Model P70 386 (taller and thinner) and the Toshiba T5200, the only clamshell design.

YOUR ONLY PC

Most of these transportables have the power to be your only PC. You have to pay for this performance, however: expect to shell out a premium beyond the cost of a comparably equipped desktop PC from the same vendors. With leading vendors, this is about a 20 to 25 percent increase. For example, the Compaq Portable 386 with 2MB RAM and a 110MB hard disk sells for \$10,698, which is \$2,301 more than a similarly configured Deskpro 386/20e with VGA; that's a 27 percent premium. One surprising exception is IBM. A PS/2 Model P70 386 with 4MB RAM and a 120MB hard disk lists for \$8,295, while a comparable 20-MHz desktop Model 70-121 with a color VGA monitor (which is how you're likely to buy a desktop PC) costs \$10,084, or \$1,789 more.

Since these units all have monochrome displays no larger than the Toshiba T5200's 11-inch diagonal, you would probably want to add a good color monitor and a 101-key keyboard to complete your portable office. All the units provide ISA or MCA expansion slots inside, except for the aging Compaq Portable 386, which sells a two-slot clip-on expansion bustle for \$199. Most likely, you'd use one expansion slot for a modem, another for a network card.

When you're comparing slots among the ten transportables, be sure you compare free slots. Dolch, for instance, has six slots in all, but three are used for the disk controller, memory, and video, leaving three slots free. Several have proprietary modem or network slots, but unless you've run out of industry-standard slots, there is no clear-cut advantage to proprietary communications cards. Typically they cost more, and you're restricted to the most popular network interfaces.

BUYING CONSIDERATIONS

If you need as much computing power at home (or on the road) as in the office but you don't want to buy multiple 386 systems, one of these machines may be right for you. Here's the features set you should



The NEC ProSpeed 386 is one of the few currently available battery-powered portables that offer a desktop docking station. The docking station provides four ISA expansion slots (three 16-bit and one 8-bit). This gives the user the flexibility of a portable as well as the expansion capability of a desktop unit—all using one CPU.

slots—two of them, one 32-bit, the other 16-bit (see photograph above, left). Generally the ISA expansion slots remain open for use by other add-in boards, though you may have to use up a slot to bring the system to the limit of its RAM capacity. All of the portables reviewed have one or two empty slots inside, although not all of them take standard cards. Some of them, like the Compaq Portable 386, let you add special modems without using an expan-

sion slot—has the most comprehensive docking station that is actually for sale in the industry.

Whether you want to add more memory, special video cards, network cards, extra communications devices, or even more drives, current laptop and lunchbox-style portable computers give you the capability—some for the road and some for easy hookup when you get back to your desk. All the extras will cost you is money and weight. ■

look for: a 20- or 25-MHz CPU with 4MB of present memory (and the ability to expand to 8MB down the road), a fast 100MB hard disk, memory cache, a VGA monitor, a 2,400-bit-per-second modem, and FCC Class B certification.

While most of these ten look alike, they're substantially different under the skin. For starters, there's a 30 percent difference in speed between the slowest (Compaq) and fastest (Dolch) units, based on the most important of PC Labs' speed comparisons, the 80386 Instruction Mix benchmark test. Five of the ten have 25-MHz processors, and not coincidentally, they're the fastest five: the computers from Dolch, Micro Express, National Micro Systems, Tangent, and PC Brand, in descending order of performance. The others are 20-MHz: Micro Telesis, Toshiba, Pan United, IBM, and Compaq, also in order.

While most of these ten look alike, they're quite different under the skin. For starters, there's a 30 percent difference in speed between the slowest and fastest units.

Within the two groups, the fastest and slowest performers are separated by about 15 percent. The three fastest 20-MHz and the three fastest 25-MHz portables have memory caching.

Display technology is primarily glass plasma, with its characteristic bright-orange-on-dim-orange display. Glass plasma is power-hungry, but that's of little consequence on AC-only machines. Dolch uses greenish-yellow-tinted electroluminescent panels. Five of the machines offer VGA displays (640 by 480 resolution): Dolch, PC Brand, Toshiba, Pan United, and IBM. You shouldn't settle for anything less on this caliber of machine. The vendors who offer only EGA (640 by 350) or double-scan CGA (640 by 400)—but good luck trying to find comput-

ible software) will tell you that you can't tell the difference. You can, especially when you hook up an external monitor.

In the past, portable displays—gas plasma, electroluminescent, or liquid crystal—haven't been very good at translating colors to gray shades on the built-in panels. Several of the units reviewed here have 16-shade video controllers, and they yield noticeable improvements in quality, especially on the IBM PS/2 Model P70 386. You'll probably like the IBM and Toshiba displays best because they're the biggest, with 10- and 11-inch (diagonal) screens, respectively. All, of course, output a gray-scaled monochrome image to the built-in screen—and provide full color when hooked to external color monitors.

Alas, at review time the external-monitor-method was still the only way of viewing an image generated by a portable in color. The NEC Prospeed CSX should be available by the time this issue is published, but this sole color offering is "only" built around a 386SX. (For a First Looks review of the CSX as well as a comprehensive assessment of the state of portable color technology, please see "NEC Breaks New Ground with First Color Portable," October 31, 1989.)

Typically, all the machines in this review can be ordered with a small hard disk of about 40 megabytes (our test configuration) or a larger, faster ESDI unit of about 100MB. All can be obtained with 3.5-inch 1.44MB floppy disk drives. If you need a 5.25-inch internal floppy disk drive instead, look to the Compaq, Dolch, National Micro Systems, and PC Brand units.

All the machines allow 8MB or more of memory, and all have keyboards with separate numeric keypads, but only the IBM provides separate QWERTY, cursor, and numeric keypads with its 18-inch width. All weigh 20 to 25 pounds; the Toshiba T5200 is the lightest, at 19.5 pounds.

REVIEW CRITERIA

To be included in this review, each unit had to be a self-contained transportable (all-in-one system unit, display, and keyboard) with a 20-MHz or faster 80386 processor. It had to provide at least 4MB of system memory, room for both a hard disk and a floppy disk drive, and the ability for you to install at least one classic-bus or Micro Channel expansion card. We asked vendors to send the best possible display and a 40MB hard disk; most also provide a

disk of about 100MB capacity.

We chose not to review the slower 386 portables loping along at 12 or 16 MHz. Some, like the GRiDCase 1530, provide battery power (typically for an hour), but most of them are over the hill and likely to be supplanted within the next year by 386SX portables, particularly once Intel releases a revision of the SX chip (next spring) with markedly lower power consumption. A handful of the machines reviewed here support a battery option, but this is not something you should seriously consider. A case in point is the Dolch battery: 20 pounds (43 pounds total with the PC), \$400, and with less than an hour of claimed life expectancy.

As always, reviews are arranged in alphabetical order. The features table, which in the past has been arranged in increasing order of base price, is now arranged on the basis of prices for *PC Magazine's* standard configuration; we believe this provides a fairer ranking. Note, of course, that machines available through retail, especially the IBM, Compaq, and Toshiba, can be had at discounts of 20 to 30 percent, while most of the others are sold through direct-marketing channels at their list prices.

COMPAQ COMPUTER CORP.

Compaq Portable 386

by Kellyn Betts

In a market where the state of the art is assessed almost by the minute, the Compaq Portable 386 seems an anachronism. The first 20-MHz 386 transportable introduced, Compaq's 20-plus-pound lunchbox design has been copied and expanded on by most of its rivals. Amazingly, down to its base price of \$7,999, the Compaq 386 portable remains fundamentally unchanged.

That price can get pretty steep. In fact, the Portable 386 configuration we tested—including 2MB of RAM, a 110MB hard disk, one 1.2MB 5.25-inch floppy disk drive, an 80387 math coprocessor, a 2,400-bps modem, and DOS 3.31—sets you back \$12,686, making this the most expensive machine we actually touched. The price for its version of our standard configuration (with 2MB RAM, a 40MB hard disk, the best available display, and DOS) was also the highest.

The Portable 386 was introduced in September 1987 and won a *PC Magazine*

COVER STORY
386-BASED PORTABLES



With benchmark test scores toward the low end of the scale, the Compaq Portable 386 has a high-end price. \$8,848 buys you a machine with 2MB RAM, a 40MB hard disk, one 1.2MB floppy disk drive, an EGA gas plasma display, and DOS 4.0.

Award for Technical Excellence that year as "the hottest thing you could pick up with a handle." When it was covered in a comparative review ("Take It or Leave It: Portables with Desktop Power," October 11, 1988), it was "yesterday's screamer," but "still a top choice." Now it's simply a well-constructed AC-bound transportable that costs more (even with the typical 20 to 30 percent discounts available) and gives you less than most of its competitors.

If you're buying a 386 portable for speed (which seems the logical reason, given the weight, cost, and battery-life deficiencies of the breed), the Portable 386 will not overwhelm you. Largely because of its lack of a memory cache, processor and memory performance on PC Labs' benchmark tests were uniformly unimpressive, although the disk and video speeds were somewhat better. (A Compaq spokesperson would not say whether or not a redesigned Portable 386 with a mem-

ory cache was in the offing.)

Most of the transportables we reviewed come with two or three industry-standard expansion slots. The 9.8- by 16- by 7.8-inch Compaq unit has no ISA slots, unless you purchase and plug in its expansion chassis. Of course this chassis adds extra weight, bulk, and \$199 to the 21.7-pound unit. The Portable 386 does have two proprietary slots; these allow for memory expansion to 10MB, as well as an internal modem, but Compaq recommends that only authorized Compaq dealers open the unit to install such enhancements.

Whether you buy the unit with or without the expansion chassis, however, you won't get a VGA screen. Instead, you'll be using an 8.3- by 5.2-inch gas plasma screen with glowing orange pixels that can display up to 640 by 400 resolution, with CGA and EGA compatibility. A 9-pin RGB connector provides the same resolutions for external color video support. Compaq's display is quite readable; it springs up out of its lunchbox to about 4.5 inches above your desk and tilts to roughly a 105-degree angle. This is a good feature that other vendors have adopted, and it is now found on most transportables.

ON THE KEYBOARD

The other component that you constantly interact with is the keyboard. Compaq's 92-key unit is springy enough, but the keys feel a little sloppy and fire too easily. And they are so loose-feeling your fingers can almost fall off them, although they are of the standard size and travel distance. The full cursor pad is a plus, as is the top row of function keys if you're an IBM Enhanced keyboard fan. In fact, the Portable 386's

keyboard layout is nearly identical to the 101-key Enhanced layout—missing only the middle group of dedicated cursor-control keys. Like most of the keyboards that come with these lunchbox-type models, this one is removable (meaning that you can pull it out of its socket and replace it with a standard desktop keyboard).

You can adjust the keyboard's sound level, thanks to the key-click volume controls built into the system software. The machine comes with a number of other utilities, including ones that let you change the displayed appearance of text, use expanded memory (extended memory is the default setting), create a RAMdisk from system RAM, cache your hard disk, and use keyboards other than standard U.S. varieties.

The best thing about the Portable 386 is its ruggedness; we're sorry to report that most of the other machines required an overhaul by PC Labs' technicians. Compaq has a reputation for building reliable equipment, and its quality control is excellent. Sold through dealers, the Portable 386 comes with a full one-year warranty.

Perhaps Compaq's reputation is what enables it to continue selling an outdated machine at an outlandish price. For a slow machine, with neither VGA nor internal ISA expansion slots, the prices Compaq charges are simply too high—even in the light of its ruggedness and dependability and the 20 to 30 percent dealer discounts you can expect.

DOLCH COMPUTER SYSTEMS

Dolch P.A.C. 386-25C

by Mary Kathleen Flynn

The Dolch P.A.C. 386-25C is the fastest portable PC ever to fly through PC Labs' benchmark tests. With a 32K RAM processor cache on the motherboard, it won first place on most of our tests. Like its slightly slower sibling the Dolch P.A.C. 386-20C, which won Editor's Choice status last year ("Take It or Leave It: Portables with Desktop Power," *PC Magazine*, October 11, 1988), the Dolch P.A.C. 386-25C is a well-designed, well-constructed lunchbox powerhouse.

Pitched as a "desktop replacing portable," the Dolch 386-25C is designed for number-crunching power users—such as high-powered executives who travel frequently but work within reach of a power



FACT FILE

Compaq Portable 386

Compaq Computer Corp., 20555 State Hwy. 249, Houston, TX 77070; (713) 370-0750.
List Price: With 1MB RAM, 40MB hard disk, one 1.2MB 5.25-inch floppy disk drive, EGA gas plasma display, \$7,999; with 2MB RAM, DOS 4.0, \$8,848; with 10MB hard disk, Intel 80387-25 coprocessor, 2,400-bps modem and modem interface board, DOS 3.31, \$12,685.
In Short: A rugged portable, the Portable 386 is slow for a high-performance 386 and comes without a VGA screen or internal memory slots to recommend it. This Compaq's prices, especially for add-on options, aren't in line with those of its peers.

CIRCLE 409 ON READER SERVICE CARD



Dolch stuffs plenty of speed and power into its lunchbox. The fastest of the group, the 25-MHz Dolch P.A.C. 386-25C lists for \$8,145 with 2MB RAM, a 40MB hard disk, one 1.2MB floppy disk drive, DOS, and a double-scan CGA electroluminescent display.

outlet in hotel rooms and second homes. The Dolch 386-25C delivers all the speed, power, and expandability these high-end users need.

Customers can choose from a full palette of options and configurations. The \$7,995 base configuration includes 2MB of RAM, a 40MB hard disk, a 1.2MB 5.25-inch floppy disk drive, a double-scan CGA electroluminescent display, one serial and one parallel port, and three open 16-bit slots. Loaded up with an optional 150MB hard disk, an 80387-25 math coprocessor, and DOS (\$150 for Version 3.3

slots and comes with its own 200-watt power supply. An MNP 2,400-bit-per-second modem, which will take up a slot, costs \$240.

WHAT'S INSIDE

Inside the machine, you'll find quality components. Designed by Dolch and manufactured by Monolithic Systems, the system board is based on Chips and Technologies' 25-MHz 386 chip set. 2MB RAM comes standard, and the motherboard accepts 8MB, with 24MB as the total possible system memory. The BIOS was written by Quadrel.

The most interesting component is the RAM cache, which is controlled by Chips and Technologies' 8231 cache controller. The RAM cache makes the 386-25C the clear winner on PC Labs' three processor and memory benchmark tests—the 80386 Instruction Mix, Floating-Point Calculation, and Conventional Memory tests. Dolch's 40MB ESDI hard disk is top-notch as well, with one first-place and two second-place finishes to its credit on the tests of hard disk performance. The 386-25C is a speedy, solid machine.

As a portable, this 22.9-pound screamer isn't for everybody. By no means a lightweight, the Dolch P.A.C. 386-25C actually weighs about a pound less than the Dolch P.A.C. 386-20C (Dolch has switched from a steel to an aluminum chassis). But even with the pound shaved off, the 386-25C isn't the PC you'll be working on during your next transcontinental flight. You actually can buy a battery for it: Dolch will sell you a \$399 85-watt battery pack (not tested here), but the 20-pound-extra unit will only give you an

hour's worth of operation using either the battery or an AC-DC adapter plugged into an auto cigarette lighter. This is the only one of these machines available with a battery, but we consider the addition next to useless.

The 386-25C may not be light, but it is compact. At 9.5 by 16 by 7.8 inches (HWD), it won't overwhelm your desk-top. And this lunchbox holds lots of convenient features in its small space.

The detachable keyboard is a good case in point. Although you can replace it—it uses a standard connector—you probably won't need to. The AT-style 86-key keyboard is both roomy and comfortable, and it responds well to the touch. For number-crunchers, there's a separate numeric keypad. Two legs provide a comfortable angle. Attached by an 11-inch cable, the keyboard will also rest quite comfortably in your lap.

With a 9-inch-diagonal viewing area, the Dolch's tilt electroluminescent flat-panel display is a little smaller than the other portables' displays. But it is quite good. We recommend springing for VGA, but even the double-scan CGA display we tested wasn't hard on the eyes. You can adjust the contrast controls easily, and a switch lets you toggle between amber-on-gray and gray-on-amber.

The fastest portable on the planet, the 386-25C is a good, solid machine—backed up by a 30-day money-back guarantee and a one-year warranty. For engineers and executives who want all the speed, power, and expandability of a 386 desktop unit but also want the convenience and compactness of a portable, the Dolch P.A.C. 386-25C can't be beat.

IBM CORP.

IBM PS/2 Model P70 386

by Edward Mendelson

IBM got it right with the PS/2 Model P70 386. This surprisingly well-priced \$7,695 luggage has more RAM and more storage than most desktop machines, and at 20 MHz, it moves fast enough for any application short of full-scale CAD. Its 21.9 pounds are too much for a casual stroll around the block, but its compact shape makes the weight easier to manage. With its full-size keyboard and gas-plasma



Dolch P.A.C. 386-25C
Dolch Computer Systems, 2029 O'Toole Ave.,
San Jose, CA 95131; (800) 223-2077 (in CA),
(800) 538-7506.
List Price: With 2MB RAM, 40MB hard disk,
one 1.2MB 5.25-inch floppy disk drive, CGA
electroluminescent flat panel display, \$7,995;
with DOS 3.3 or 4.0, \$8,145; with 150MB hard
disk, 80387-25 coprocessor, carrying case,
\$11,180.
In Short: The fastest portable to date, this
lunchbox model offers all the speed, power, and
expandability high-end users need.

CIRCLE 418 ON READER SERVICE CARD

or 4.0) and wrapped in an attractive \$95 soft carrying case, the unit we tested goes for \$11,180. If you're spending this much for a portable, get the \$595 VGA display (not tested here). If you prefer to use 3.5-inch floppy disks, Dolch will sell you a 1.44MB drive for \$50. For those of you who need more than three slots, you can buy Dolch's Back-PAC expansion chassis, which contains three additional 16-bit

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COVER STORY
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Thinner and taller than the typical lunchbox transportable, the IBM PS/2 Model P70 386 offers a full-sized keyboard and a sharp VGA display. The MCA machine includes 4MB RAM, a 60MB hard disk, and a 1.44MB floppy disk drive for \$7,695.

VGA display, the Model P70 counts as a powerful AC-only desktop machine that happens to take up very little space on your desktop.

Priced lower than its desktop analog, the Model P70 measures about 12 by 18 by 5 inches (HWD) and is shaped like a thick attaché case; the shape and the rubber padded handle make it comfortable to carry. Packed neatly inside the case is a silent-running 60MB ESDI hard disk (\$600 more

the entire screen. Although the orange-red color can become slightly tiring after a few hours, this is one of the most tolerable displays we've seen on a transportable PC. Gray-scale images look sharp and detailed, and text is highly legible against the deep black background. The display remains readable even in bright daylight. The screen pulls out from the case and twists or pivots easily, but persuading it to fit back into the case can be more difficult.

To the right of the display is a single 1.44MB floppy disk drive, which can be pivoted slightly away from the case if necessary but normally nestles inside. Below the drive is a power switch, but you won't find a reset switch. IBM doesn't give you a key lock, but you can use built-in password protection instead.

The biggest surprise of the design is the sturdy full-sized keyboard. Unlike other portables with their cramped, confusing keyboards, this luxury model features a 101-key layout identical to the Enhanced keyboards that come with IBM's desktop machines. Unfortunately, the membrane-actuated keys feel more like those on a clone keyboard than the spring-loaded keys of the classic IBM models.

A sliding door on the rear panel of the Model P70 swings back to reveal a serial and a parallel port, a PS/2 mouse port, and a new rectangular connector for IBM's external floppy disk drives. The sliding door is built into a larger swing door, which gives access to a video connector where you can plug in a VGA monitor for color viewing.

The same door gives you access to the brackets of the two MCA expansion slots.

Unlike other MCA machines, the Model P70 puts its two slots on the same plane, immediately behind the back panel of the case. One slot can accept a 32-bit full-length MCA card; the other is a half-length 16-bit MCA slot that's just right for IBM's \$449 2,400-bps internal modem.

THE TURN OF THE SCREW

As with all PS/2 models, you can open the back of the case by turning a few screws with a coin. Once inside, you have easy access to the battery for the CMOS RAM, the socket for an 80387 coprocessor, the snap-in connectors for the four 2MB SIMMs that make up the Model P70's motherboard RAM, and the two expansion slots. The full-length slot for IBM's PS/2 Enhanced 80386 Memory Option card, which holds up to 16MB of additional RAM using IBM's new 4-megabit chips, should be available by the time this issue hits the newsstands, but 16MB is the total system memory as well.

Beneath the expansion cards is the motherboard, which has a surprisingly large number of last-minute wire traces. At the bottom of the case is a tiny and quiet 90-watt power supply, plus the 3.5-inch hard disk.

In PC Labs' benchmark tests, the Model P70 performed roughly in the middle of

The biggest surprise
of the Model P70's
design is its sturdy
full-sized keyboard.

the 20-MHz pack. The 120MB hard disk in the test unit was a respectable performer. We didn't test the 60MB disk option, but not even IBM suggests that its performance will dazzle anyone.

The Model P70 comes with a one-year warranty from IBM. If you need technical support, you'll have to go to your dealer and beg for it.

All in all, however, the IBM PS/2 Model P70 386 is one of the most impressive, powerful, and usable portable computers that you can find. Its reasonable price (compared with the offerings from Compaq and Toshiba) makes it quite an enticing prospect.

PC
MAGAZINE

FACT FILE

IBM PS-2 Model P70 386
IBM Corp.; (800) IBM-2468.
Contact your local authorized IBM dealer.
List Price: With 4MB RAM, 60MB hard disk, one 1.44MB 3.5-inch floppy disk drive, VGA gas plasma display, \$7,695; with 120MB hard disk, \$8,295.
In Short: At 21.9 pounds, IBM's lunchbox luggable isn't lightweight in either features or portability. But it has an easy-to-carry shape, and it packs in 4 MB RAM, two MCA slots, a full-sized Enhanced keyboard, and a bright and readable gas-plasma VGA screen. This is IBM's first successful portable machine, worthy of any desktop.

CIRCLE 411 ON READER SERVICE CARD

gets you 120MB) plus 4MB of 85-nano-second RAM (expandable to 8MB on the motherboard), of which 128K is used to place the BIOS in fast shadow RAM.

When you fold down or lift away the keyboard, which serves as the front panel of the case when the machine is closed, you are faced with a VGA display that measures 10 inches diagonally. CGA and EGA graphics are supported but won't fill

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386-BASED PORTABLES: SUMMARY OF FEATURES

(Products listed in ascending price order)

The following commentary analyzes some of the terms in this table of features. The phrases in bold type are listed in the same order as in the left-hand column of the table.

Standard configuration For the sake of price comparisons, our "standard" configuration includes 2MB RAM, a 40MB hard disk, one high-density floppy disk drive, a video display, at least one parallel and one serial port, DOS, and a keyboard. Because the "standard" packages cited here may differ from this configuration, the price of each system is followed by any departures from our specification.

Basic configuration This price represents the most stripped-down machine the vendor will sell, typically including 1MB RAM, a hard disk, one floppy disk drive, video display, serial and parallel ports.

Tested configuration The specifications and performance results of the evaluation units depend on the configuration each manufacturer has sent us.

The BIOS version and date may affect PC Labs' benchmark test results. Those purchasing the same machine with a different BIOS version may encounter some variations in performance.

Chip size Kb and Mb refer to kilobits and megabits, respectively.

Chip packaging Memory chips come in a variety of styles: DIPs, SIPs, and SIMMs. The Dual In-line Package (DIP) is the traditional buglike computer chip sprouting 8, 14, 24, or even 40 or more metal legs (evenly divided between right and left sides). Single In-line Packages (SIPs) are single-package arrays of computer chip logic assembled so that all connecting legs are in a straight line, like the teeth on a comb. Single In-line Memory Modules (SIMMs), on the other hand, are individual logic devices that are installed on their own small circuit board, creating a component module that can be plugged into a larger device. Their physical arrangement facilitates replacing an individual memory module if necessary.

Chip type RAM chips come in two basic types: static and dynamic. Static RAM chips (SRAMs) are faster and more efficient but costlier. Dynamic RAM chips (DRAMs) cost less and are more common, but the tradeoff is in slower processing and operation.

Disk cache software Some companies provide software to facilitate data retrieval from the hard disk. This software speeds overall system performance by anticipating what data the processor will need next.

Maximum 32-bit RAM Many computer manufacturers have designed their own 32-bit slots for memory expansion cards. The availability of such slots is especially important for a growing number of memory-intensive applications.

Interleaved memory CPU speed is usually faster than conventional memory speed. Interleaved memory increases processing speed by splitting the memory into two or more portions. The CPU then sends information to a section of it at a time, allowing one section to process while another receives data.

Shadow RAM Shadow RAM is a technology that loads system BIOS and/or video BIOS directly into fast RAM on boot-up of the computer, offering enhanced performance speed at the cost of 384K of memory in the first 1MB of system RAM.

Processor RAM cache A processor RAM cache acts as a bridge between the CPU and the slower main memory. The cache is comprised of a small bundle (typically 32K to 128K) of fast SRAM chips. The cache controller is designed to predict and retrieve the data the CPU is likely to require next, thus preventing wait states. There are two varieties of controllers: discrete-logic chips (designed by the individual manufacturers) and VLSI chips like the Intel 82385.

	Micro Telele EGA Gae Plasma 386-c	Micro Express Regal II	Tangent 386/25 Portable	Nationtel Micro Systeme Gae Plasma 386-25	PC Brand 386/25 VGA Portable III
STANDARD CONFIGURATION					
Price of system with 2MB RAM, 40MB hard disk, display, and DOS	\$2,949	\$3,274	\$3,528	\$3,749	\$4,000
BASIC CONFIGURATION					
List price	\$2,699	\$2,999	\$2,765	\$3,499	\$3,225
Basic configuration includes	1MB RAM, 40MB hard disk, 1.2MB or 1.44MB floppy disk drive, CGA display, 1 serial and 1 parallel port, DOS 3.3	1MB RAM, 40MB hard disk, 1.44MB floppy disk drive, EGA display; 1 serial, 1 parallel, and 1 game port	1MB RAM, 20MB hard disk, 1.44MB floppy disk drive, double-scan CGA display; 1 serial, 1 parallel, and 1 game port	1MB RAM, 40MB hard disk, 1.2MB floppy disk drive, CGA display, 1 serial and 1 parallel port	1MB RAM, 40MB hard disk, 1.2MB or 1.44MB floppy disk drive, CGA display, 1 serial and 1 parallel port
TESTED CONFIGURATION					
List price	\$3,399	\$4,499	\$5,995	\$5,048	\$7,000
Tested configuration includes	2MB RAM, 80MB hard disk, 1.44MB floppy disk drive, EGA display, DOS 3.3	4MB RAM, 80MB hard disk, 1.44MB floppy disk drive, EGA display, 80387-25, DOS 4.01	8MB RAM, 138MB hard disk, 1.44MB floppy disk drive, EGA display, DOS 3.3	4MB RAM, 80MB hard disk, 1.2MB floppy disk drive, CGA display, 80387-25, DOS 3.3	8MB RAM, 150MB hard disk, 1.2MB and 1.44MB floppy disk drives, VGA display, 80387-25, DOS 4.01
PHYSICAL SPECIFICATIONS					
Dimensions (HWD, inches)	8.2 x 16.1 x 9.1	10.4 x 15.9 x 8.5	10.4 x 15.9 x 8.5	8.2 x 16.1 x 9.1	9.7 x 16.2 x 8.2
Weight (pounds)	23.57	22.93	21.96	23.0	25.24

☐—Editor's Choice ■—Yes ☐—No

N/A—Not available: the product does not have this feature

MICRO EXPRESS

Micro Express
Regal II

by Bruce Brown

Controller type Within the 386 PC environment, the three most common hard disk interfaces are ST-506, SCSI (Small Computer System Interface), and ESDI (Enhanced Small Device Interface). Both SCSI and ESDI require special hard disk controllers and cannot run off existing PC-XT or PC AT controllers.

ST-506 uses one of two data encoding methods, RLL (Run Length Limited) or the older MFM (Modified Frequency Modulation) scheme. All data is encoded onto and read from your hard disk as a series of polarity-reversing bits representing ones and zeros. Nine such bits would be needed to store 12 bits of data in MFM format, and only six polarity changes are required with RLL format; thus, MFM takes more space than RLL.

Display type Among portables, standard displays include liquid crystal displays (LCDs) with or without backlighting, electroluminescent (EL) displays, and gas plasma displays, known for their orange glow and superior gray-scale ability. The table describes the display used in each tested configuration; in some cases, an LCD is also available at a lower price.

Video modes supported The video standards internally supported by each portable range from VGA down to the Hercules Graphics Adapter (HGA) and

monochrome display adapter (MDA).

External displays supported by built-in video hardware These are all video modes that the portable can output to a separate external monitor, not to the included display.

Bus clock speeds Bus speed becomes more important as computers run at faster clock speeds. A computer's bus speed may actually be too fast for expansion cards, most of which operate at 8 MHz.

Hard disk options The number of different hard disks the vendor offers for a machine is often indicative of how much customizing is available.

FCC certification class Two classes of FCC (Federal Communications Commission) approval may be given to computers: Class A and Class B. These classes concern levels of radio-frequency interference. With Class A approval, a computer may be operated in a business locale. The tougher Class B rating allows home use as well, where computers are likely to be placed near radios and television sets.

Certification tests must be performed by private testing companies. The passing results are then sent to the FCC for final certification, a process that can take several months.



Micro Labs 386/20 L	IBM PS/2 Model P70 386	Toshiba T5200	Dolch P.A.C. 386-25C	Compaq Portabilis 386
\$4,039	\$7,895 (with 4MB RAM, 60MB hard disk, no DOS)	\$7,899	\$8,145	\$8,848
\$3,696	\$7,695	\$7,699	\$7,995	\$7,999
1MB RAM, 20MB hard disk, 1.44MB floppy disk drive, VGA display, 1 serial and 1 parallel port	4MB RAM, 60MB hard disk, 1.44MB floppy disk drive, VGA display; 1 serial, 1 parallel, and 1 mouse port	2MB RAM, 40MB hard disk, 1.44MB floppy disk drive, VGA display, 2 serial and 1 parallel port, DOS 3.3	2MB RAM, 40MB hard disk, 1.2MB floppy disk drive, doublescan CGA display, 1 serial and 1 parallel port	1MB RAM, 40MB hard disk, 1.2MB floppy disk drive, EGA display, 1 serial and 1 parallel port
\$3,846	\$8,295	\$9,298	\$11,180	\$12,686
1MB RAM, 43MB hard disk, 1.44MB floppy disk drive, VGA display	4MB RAM, 120MB hard disk, 1.44MB floppy disk drive, VGA display	4MB RAM, 100MB hard disk, 1.44MB floppy disk drive, VGA display, DOS 3.3	2MB RAM, 150MB hard disk, 1.2MB floppy disk drive, doublescan CGA display, 80387-25, DOS 3.3, carrying case	2MB RAM, 110MB hard disk, 1.2MB floppy disk drive, EGA display, 80387-25, DOS 3.31, 2,400-bps modem and board
9.9 x 18.1 x 9	12 x 18.3 x 5	3.9 x 14.8 x 15.6	9.5 x 16 x 7.8	9.8 x 16 x 7.8
22.62	21.67	19.45	22.67	21.66

CONTINUES

Ideally, choosing a 386 portable computer should include clearly prioritizing your decision-making criteria. If you're looking for speed, price, and standard components in a lunchbox-style portable computer, the 25-MHz Micro Express Regal II bears close scrutiny. The Regal II is a commendable luggable from many perspectives.

The base configuration of the Regal II costs just \$2,999 and includes 1MB of RAM; a 40MB hard disk; one 1.44MB floppy disk drive; an EGA gas plasma display; single serial, parallel, and game ports; and utility, setup, and diagnostic software.

The Regal II measures 10.4 by 15.9 by 8.5 inches (HWD) and bears an FCC Class B rating. Weighing in at 22.93 pounds on



FACT FILE

Micro Express Regal II
Micro Express, 1801 Carnegie Ave., Santa Ana, CA 92705; (800) 642-7621.

List Price: With 1MB RAM, 40MB hard disk, one 1.44MB 3.5-inch floppy disk drive, EGA gas plasma display, utilities, \$2,999; with 2MB RAM, DOS 4.01, \$3,274; with 4MB RAM, 80MB hard disk, 80387-25 coprocessor, \$4,499.
In Short: The Micro Express Regal II is a lunchbox-style 25-MHz machine with standard 64K memory cache and EGA gas plasma display. The combination of fast processor performance, good price, and four months' on-site service make the Regal II a machine to consider.

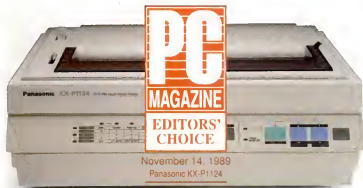
CIRCLE 413 ON READER SERVICE CARD

PC Labs' digital scale, the tested configuration has 4MB of RAM, an 80MB hard disk, and an 80387-25MHz math coprocessor for just \$4,499, an impressively low price for this much computer.

Micro Express uses an AMI motherboard with a Chips and Technologies 386 chip set, and the AMI BIOS with setup in ROM. The processor runs at 25 MHz but can be slowed to 8 MHz, which is also the expansion bus speed.

The Regal II's cache memory helped it score extremely well on our processor and memory benchmark tests, though its hard disk and video test scores were unexceptional. The memory cache consists of 64K of 25-nanosecond static RAM chips; there

The 1100 Series. The next generation in printers.



KX-P1124



KX-P1191

A highly-sophisticated 24-pin. And two companion 9-pins. These are the remarkable dot matrix printers which make up the 1100 Series from Panasonic.*

They'll meet your needs today—and tomorrow—with flexible paper handling, multiple resident fonts and unsurpassed ease of operation.

For the demands of the present, each 1100 Series printer offers advanced features, ergonomic design, and attractive prices to suit the requirements of a business, a department, an application or an individual.

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Versatile paper handling to meet all of your needs.

In engineering the 1100 Series printers, Panasonic placed a high priority on paper handling. With that in mind, an ingenious push/pull tractor feed system was incorporated into the 1100 Series. The idea was not

simply to accommodate a plethora of paper shapes, sizes and weights, but to allow the user to handle everything from single sheets to multi-part forms to fanfold paper—even envelopes and labels—quickly and easily.

All 1100 Series printers can accommodate single sheets in both landscape and portrait orientation.

So presentations incorporating graphics with text present no problem.

All 1100 Series printers offer multiple paper paths for continuous paper. And since paper can be fed from your choice of bottom or rear, you can put an 1100 virtually anywhere.

All 1100 Series printers have semi-automatic paper loading.

So sheets are perfectly positioned the first time in.

All 1100 Series printers automatically locate

the perforation on fanfold paper, bring the perf to the tear bar for easy tearing, and

then position the next sheet of paper for printing. Without wasting a single sheet. And all 1100 Series printers have a 'paper park' capability. On demand, continuous paper is retracted and 'parked' so that sheet paper and envelopes can be loaded and printed

without unloading—and wasting—the fanfold paper.

Thousands of ways to exercise creativity.

The variety of type styles, sizes and weights that can be created on

Draft Pica
Draft Elite
Courier Pica
Prestige Elite
Bold Proportional
Space
Sans Serif Pica
Script Pica
(1124 only)



Only one paper path is available at any given time for continuous paper.
1124 printer shown.

	10	12	14	16	18	24	36	48
Normal	10	12	14	16	18	24	36	48
Bold	10	12	14	16	18	24	36	48
Italic	10	12	14	16	18	24	36	48
Underline	10	12	14	16	18	24	36	48
Strikeout	10	12	14	16	18	24	36	48
All Caps	10	12	14	16	18	24	36	48
Small Caps	10	12	14	16	18	24	36	48
Superscript	10	12	14	16	18	24	36	48
Subscript	10	12	14	16	18	24	36	48
Text Color	10	12	14	16	18	24	36	48
Background Color	10	12	14	16	18	24	36	48
Text Color & Background Color	10	12	14	16	18	24	36	48
Text Color & Background Color & Underline	10	12	14	16	18	24	36	48
Text Color & Background Color & Underline & Strikeout	10	12	14	16	18	24	36	48
Text Color & Background Color & Underline & Strikeout & All Caps	10	12	14	16	18	24	36	48
Text Color & Background Color & Underline & Strikeout & All Caps & Small Caps	10	12	14	16	18	24	36	48
Text Color & Background Color & Underline & Strikeout & All Caps & Small Caps & Superscript	10	12	14	16	18	24	36	48

Page 1 of 1

Performance runs in the family.



KX-Pt180

Resident type fonts on all 1100 Series printers include draft pica and elite, letter-quality or near-letter-quality Courier, Prestige, Bold PS and Sans Serif. Plus Script on the 1124.

All these resident LQ or NLQ fonts are available in ten different character sizes.

And print speeds go from 38 to 63 cps in letter-quality/near letter quality. And from 160 to 240 cps in draft.

The 1100 Series printers also produce graphics as well as they handle text. Resolution is crisp, clear, precise. With bit image matrixes from 240x216 dpi to 360x360 dpi.

All of these features enhance your ability to create—and be creative.

The EZ Set™ Operator Panel puts features at your fingertips.



1124 printer shown.

*Epson is a registered trademark of Seiko Epson Corporation.

**IBM is a registered trademark of International Business Machines Corporation.

***The complete warranty is available for review at your Panasonic Dealer.

The 1100 Series printers were designed for non-software experts.

The EZ-Set™ Operator Panel allows you to make choices simply and quickly—without having to program any software.

The ergonomic design presents you with settings for the features you use most. Fonts, pitch, form length and many more choices can be pre-set on the panel. And the 1124 even has a Macro feature that allows you to easily save and recall all the panel settings for three different formats.

Selectable on the EZ-Set™ Operator Panel:

- Fonts: 4 to 6, depending on model
- Pitch: 4 to 6, depending on model
- Form Length: From 8" to 14"
- Quiet Mode: Cuts printer noise by 50%
- Micro Line Feed: forward and reverse
- Perforation Cut

- Self Test
- And more

Plus the protection of a two-year warranty.

The 1100 Series is a family of full-featured 24- and 9-pin printers. Compatible with the rich software libraries supporting both Epson* and IBM** dot matrix printers. And protecting your investment with something you'll find on very few printers out there: a two-year warranty*** on both parts and labor, from Panasonic.

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386-BASED PORTABLES: SUMMARY OF FEATURES

(Products listed in ascending price order)

	Micro Teleis EGA Gas Plasma 386-c	Micro Express Regal II	Tangent 386/25 Portable	National Micro Systems Gas Plasma 386-25	PC Brand 386/25 VGA Portable III
SYSTEM SPECIFICATIONS					
Microprocessor clock speeds (MHz)	8/20	8/25	8/12.5/25	8/25	8/16/25
BIOS version and date	Phoenix BIOS Plus, Version 1.10 00 (March 1989)	AMI BIOS, Version 386 DAMI 3606 (April 1989)	AMI BIOS, Version 386 EC&T 1102 (March 1989)	AMI BIOS, Version 386 DAMI 3606 (April 1989)	AMI BIOS, Version 386 DC&T 5004 (April 1989)
System board manufacturer	ATI	AMI	Data Expert	AMI	PC Brand
386 chip set manufacturer	Chips and Technologies	Chips and Technologies	Chips and Technologies	Chips and Technologies	Chips and Technologies
MEMORY SPECIFICATIONS					
Chip size	256Kb, 1Mb	1Mb	256Kb, 1Mb	1Mb	256Kb, 1Mb, 4Mb
Chip speed (nanoseconds)	100	80	80	80	80
Chip packaging	SIMM	DIP	SIP	DIP	SIP
Chip type	DRAM	DRAM	DRAM	DRAM	DRAM
Wait states	0	0	0.5	0	0.5
Disk cache software	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Maximum 32-bit RAM	8MB	18MB	16MB	8MB	18MB
Maximum RAM on motherboard	8MB	N/A	8MB	N/A	16MB
Interleaved memory	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Shadow RAM	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Shadowing can be turned off	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> (video only)	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
EMS drivers included	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
PROCESSOR RAM CACHE					
Maximum cache size	64K	64K	N/A	64K	N/A
Installed cache size	32K	64K	N/A	64K	N/A
Cache memory speed (nanoseconds)	35	25	N/A	25	N/A
Cache controller	Altronic	Discrete logic	N/A	Motorola	N/A
DISK CONTROLLER					
Disk controller manufacturer	Seagate	DTC	CDC	Western Digital	Adaptec
Controller type	SCSI	ESDI	ESDI	ST-506	ESDI
Number of drives handled by controller	7	4	4	4	4
Empty drive bays	None	None	None	None	1 half-height
DISPLAY					
Display type	Gas plasma	Gas plasma	Gas plasma	Gas plasma	Gas plasma
Maximum resolution (pixels)	640 x 400	640 x 400	640 x 400	640 x 400	640 x 480
Video modes supported	EGA, CGA, HGA	EGA, CGA, MDA	EGA, CGA, MDA	Double-scan CGA, HGA	VGA, EGA, CGA, HGA, MDA
Viewable area (W x H, inches)	8.4 x 5.4	8.25 x 5.25	8.25 x 5.25	8.4 x 5.4	7.75 x 5.75
Readability	Very good	Very good	Very good	Very good	Very good
KEYBOARD					
Number of keys	88	102	102	98	88
Cable length (inches)	16	24	24	16	18
Detachable keyboard	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Plug for external keyboard	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

☐—Editor's Choice ☒—Yes ☐—No

N/A—Not available: the product does not have this feature.

is no separate cache controller chip, as the cache circuitry is built onto the motherboard. With the cache enabled, there are essentially no memory wait states on cache hits.

All user RAM is on a memory card installed in the single 32-bit expansion slot. The memory chips are 80-ns. DRAM DIP-style chips. The standard memory card is capable of holding up to 8MB RAM; an optional \$150 daughterboard can take another 8MB, for a system maximum of 16MB of 32-bit RAM.

The Regal II uses both memory interleaving and RAM shadowing. You can choose whether to shadow video BIOS, but ROM BIOS shadowing is standard and can't be turned off. If you don't shadow the video BIOS, you can use the top 256K of the first 1MB of RAM for extended memory. Micro Express includes Quarter-

The Regal II's
cache memory helped
it score extremely
well on our
processor and
memory benchmark
tests, though its hard
disk and video test
scores were
unexceptional.

deck Office Systems' QEMM-386 memory management software for LIM/EMS 4.0 compatibility.

The attached keyboard, which can be unplugged and replaced by any AT-compatible keyboard, is a 102-key unit with two rows of six function keys each on the top-left side of the keyboard and a second set of cursor-control and page-positioning keys on the upper-right side. The keyboard is responsive and pleasant to use, with a generous 24-inch cable.

The EGA gas plasma screen is easy to look at, with high-contrast amber characters against a black background. Although



Micro Labs 386/20 L	IBM PS/2 Model F70 386	Toshiba T3200	Dolch P.A.C. 386-25C	Compaq Portable 386
8/20 AMI BIOS, Version 386 DAMI 3601 (March 1989) AMI	8/20 IBM BIOS, 1989 Version 3601 (March 1989) IBM	8/20 Toshiba /Award BIOS, Version 1.2 (October 1988) Toshiba	8/25 Quadtel BIOS, Version 3.03 (August 1988) Monolithic (Dolch design) Chips and Technologies	6/9/20 Compaq BIOS, Version K.3 (November 1988) Compaq
Chips and Technologies	IBM	Toshiba	Chips and Technologies	Compaq
256Kb, 1Mb 100 DIP DRAM 0 0 16MB N/A □ □ N/A □	1Mb 85 SIMM DRAM 0 16MB 8MB □ □ N/A □	1Mb 80 SIMM DRAM 1 8MB 8MB □ □ N/A □	256Kb, 1Mb 80 SIMM DRAM 0 24MB 8MB □ □ N/A □	256Kb 80 SIMM DRAM 0 10MB 2MB □ □ N/A □
64K 64K 25 Discrete logic	N/A N/A N/A N/A	32K 32K 35 Intel 82385	32K 32K 35 Chips and Technologies 8231	N/A N/A N/A N/A
National Computer ST-506 4 1 one-third	IBM DBA 1 None	Conner Conner proprietary 2 None	Toshiba ST-506 4 2 half-height	Compaq ST-506 1 1 half-height
Gas plasma 640 x 480 VGA, EGA, CGA, HGA, MDA 8.25 x 6.25 Good	Gas plasma 640 x 480 VGA, EGA, CGA, HGA, MDA 8.4 x 6.3 Excellent	Gas plasma 640 x 480 VGA, EGA, CGA, MCGA 9 x 6.75 Excellent	Electroluminescent 640 x 400 Double-scan CGA (MGA, \$595) 7.7 x 4.8 Very good	Gas plasma 640 x 400 EGA, CGA 6.3 x 5.2 Good
103 24 ■ ■	101 16 ■ □	91 N/A □ □	86 11 ■ ■	92 30 ■ ■

CONTINUES

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HYUNDAI

CIRCLE 525 ON READER SERVICE CARD

COVER STORY
386-BASED PORTABLES



386-BASED PORTABLES: SUMMARY OF FEATURES

(Products listed in ascending price order)

	EGA Gas Plasma 386-c	Micro Telele Micro Express Regal II	Tangent 386/25 Portable	Systems Gas Plasma 386-25	National Micro PC Brand 386/25 VGA Portable III
POWER					
Power supply (watts)	220	200	200	180	180
Battery	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Car battery adapter	Optional (\$189)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
IO AND EXPANSION					
External displays supported by built-in video hardware	CGA, HGA	EGA, CGA	EGA, CGA, HGA, MDA	Double-scan CGA, HGA	VGA, EGA, HGA, MDA
External display connector	DB-9	DB-9	DB-9, 2 composite RCA's	DB-9	DB-15
External floppy disk drive port	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Expansion slots	Two 8-bit, four 16-bit, one 32-bit	Two 8-bit, four 16-bit, one 32-bit	Two 8-bit, four 16-bit, two 32-bit	One 8-bit, six 16-bit, one 32-bit	Three 8-bit, five 16-bit
Slots free and accessible	5	1	2	5	5
Bus clock speeds (MHz)	8	8	8, 8.3, 12.5	8, 8.33	8
Software included:					
Disk-based	Diagnostics	QEMM-386 memory manager, utilities	None	None	Setup, diagnostics, utilities
ROM-based	Setup	Setup, diagnostics	None	None	Setup
OPTIONS					
Supports 80387	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Supports Wetek	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Internal modem (bps)	1,200 (\$115)	1,200 (\$99), 2,400 (\$169)	2,400 (\$139), 9,600 (\$790), 19,200 (\$1,190)	1,200 (\$69), 2,400 (\$140)	1,200 (\$49), 2,400 (\$79), 2,400 MNP (\$130)
Carrying case	Standard	Standard	None	Standard	Cordura, \$45
Expansion chassis	None	None	None	None	None
OPTIONAL STORAGE					
Floppy disk drives	External 1.2MB	External 1.2MB	External 1.2MB	None	External 1.2MB, 1.44MB; internal 1.2MB, 1.44MB
Hard disk options (MB)	20, 40, 80, 200	40, 80, 100, 200	45, 67, 85, 138	80	40, 66, 71, 150
OTHER					
Warranty	13 months	1 year, 4 months on-site	1 year	1 year	5 years prorated
30-day money-back guarantee	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Distributed through dealers or direct	Direct	Direct	Both	Direct	Both
FCC certification class	A (pending)	B	A	B	A
Password security	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

☐—Editor's Choice ☒—Yes ☐—No

N/A—Not available: the product does not have this feature.

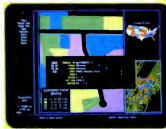
Micro Labs 386/20 L	IBM PS/2 Model P70 386	Toshiba T5200	PC Dolch P.A.C. 386-25C	Compaq Portable 386
160	85	Information not available	200	145
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Optional (\$399)	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Included with optional battery	<input type="checkbox"/>
VGA, EGA, CGA, HGA, MDA	VGA	VGA	Double-scan CGA	EGA, CGA
DB-9, DB-15	DB-15	DB-15	DB-9	DB-9
<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
One 8-bit, three 16-bit, one 32-bit	One 16-bit half-length, one 32-bit	One 8-bit (or proprietary 16- bit), one 16-bit	Six 16-bit, two 32-bit	One proprietary modern, one 32-bit
5	2	2	3	2
8	10	8, 10	8, 12, 5	6, 8, 20
Utilities	Diagnostics	QEMM-386 memory manager, on-line help	None	None
Setup	IBM BASIC	None	None	None
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
2,400 (\$125)	2,400 (\$449)	2,400 (\$399)	2,400 MNP (\$240)	1,200 (\$349), 2,400 (\$599)
Standard	Nylon, \$180; leather, \$350	Nylon, \$99; leather, \$299	Nylon, \$95	Nylon, \$89; leather, \$225
None	None	Five 8-bit slots, \$999	Three 16-bit slots, \$795	Two 16-bit slots, \$199
None	External 360K	External 360K	Internal 1.44MB	Internal 360K, 1.44MB
40, 85, 150	60, 120	100	150	110
1 year	1 year	1 year	1 year	1 year
<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Both	Dealers	Dealers	Both	Dealers
B (pending)	B	B	A	B
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

ENDS

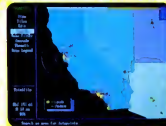
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CIRCLE 291 ON READER SERVICE CARD



The \$3,274 Micro Express Regal II—a 25-MHz luggable—isn't the fastest, but it is plenty fast enough. With 2MB RAM, a 40MB hard disk, one 1.44MB floppy disk drive, EGA gas plasma display, and DOS 4.01, it warrants your consideration.

brightness and contrast controls are small, many of the transportables provide the user with just one control knob. The Regal II's controls are slide levers located on the lower-right side of the screen. Another good feature is the ability to turn the screen off with the system still on, using a separate display-power switch on the back of the case.

Beyond the 32-bit memory slot, additional accessible slots include one 8-bit slot and three 16-bit slots, although only one 16-bit slot was free in our tested configuration. Three more 16-bit slots are blocked by the 200-watt power supply.

In addition to the standard parallel, 25-pin serial, and 15-pin game ports, there is a 9-pin video port for an external EGA-compatible monitor. There's also a port on the back of the computer for an external 5.25-inch 1.2MB floppy disk drive, a \$149 option. Other important options include an 80387-25 math coprocessor (\$490) and a 2,400-bit-per-second Hayes-compatible internal modem (\$169).

Micro Express sells its computers only through mail order. All units come with a one-year parts-and-labor warranty and on-site service for the first four months of ownership. If warranty service requires shipping to Micro Express's California facility, the company pays for ground shipping both ways, though you may be tempted to pay extra for air shipping. There's also a 30-day money-back guarantee. Toll-free support calls are available but limited to 9:30 to 6:30 Pacific Time.

The Micro Express Regal II is a competent machine at an attractive price. This 25-MHz computer uses standard compo-

nents in a typical lunchbox design. While the Regal II isn't the fastest machine overall, it comes close, and its standard memory caching and memory interleaving enhance processor and memory performance. Features, price, performance, and service and support policies all score well in the Micro Express formula.

MICRO TELESIS INC.

Micro Telesis EGA Gas Plasma 386-c

by M. David Stone

The label on the lunchbox says Portable PC III. But don't let that fool you. This is the EGA Gas Plasma 386-c, and the company is Micro Telesis Inc. Portable PC III is the logo that comes on the OEM'd case, and Micro Telesis just didn't bother replacing it.

The price for the Micro Telesis portable in *PC Magazine's* standard configuration makes it the least expensive product of this line-up. With 2MB RAM, a 40MB Seagate hard disk, a 1.2MB or 1.44MB floppy disk drive, and an EGA gas plasma screen, it costs \$2,949. The system provided for review had only 1MB RAM, but it included the EGA display and an 80MB Seagate hard disk and controller for \$3,399.

Perhaps the most important factors on a portable are the keyboard and screen. The EGA Gas Plasma 386-c is less than ideal in both areas.

The keyboard feel is good, with an audible click and clear kinesthetic feedback. The layout is based on the original AT keyboard, except that the function keys—twelve of them—are across the top. Unfortunately, the fact that the original AT layout is used means that the keys are in different positions than on the 101-key Enhanced-style keyboard. As partial compensation, you can plug in any standard AT keyboard. The EGA screen measures 8.4 by 5.4 inches, but even with the brightness up full, it is neither as bright nor as well contrasted as I'd like; it's simply hard to read.

The physical design is standard lunchbox luggable. The screen defines the front of the unit. A nice touch is the power-on light in the upper-right corner of the screen frame and the disk access light next to it. Another apt touch is the reset switch below the display, flush against the frame, and clearly labeled *Reset* in raised letters.

For transport, the keyboard serves as a front cover over the screen. Add the handle on top and you have a well-appointed lunchbox. At a weight of 23.6 pounds and a size of 9.1 by 16.1 by 8.2 inches (HWD), "luggable" is definitely the right description.

To use the system, you slide two latches to release the keyboard and detach it from the computer. Additional setup can be as simple as plugging in the power cord. A sliding door on the left side lets you get at connectors on up to four boards. On the back, you'll find a parallel port and 25-pin serial port.

INSIDE THE LUNCHBOX

To get inside the box, you remove six screws, then detach the ribbon cables going from the serial/parallel board to the connectors on the back cover. Getting to

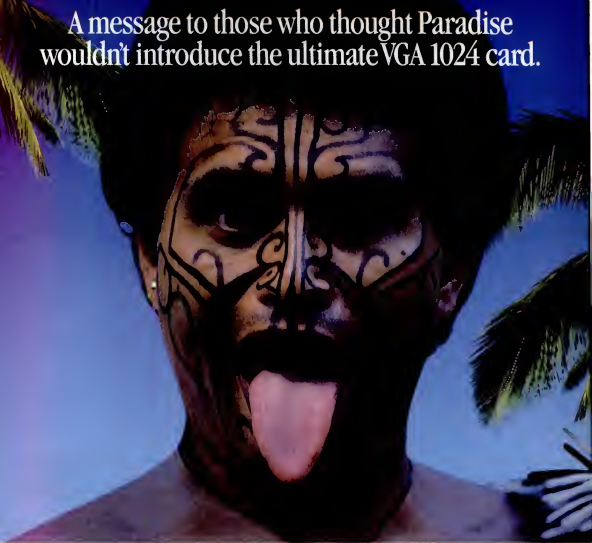


FACT FILE

Micro Telesis EGA Gas Plasma 386-c
Micro Telesis Inc., 1260 Logan A2, Costa Mesa, CA 92626; (714) 557-2003
List Price: With 1MB RAM, 40MB hard disk, one 1.2MB 5.25-inch or one 1.44MB 3.5-inch floppy disk drive, CGA gas plasma display, DOS 3.3, \$2,699; with 2MB RAM, EGA display, \$2,949; with 1MB RAM, 80MB hard disk, \$3,399.
In Short: The Micro Telesis EGA Gas Plasma 386-c is a 20-MHz luggable. The EGA screen is acceptable but not as bright as it might be.

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CIRCLE 357 ON READER SERVICE CARD

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STORAGE DIMENSIONS



With 2MB RAM, a 40MB hard disk, a choice of high-density floppy disk drives, DOS 3.3, and the screen you'd expect, the 20-MHz \$2,949 Micro Telesis EGA Gas Plasma 386-c appears to be a twin of National Micro Systems' 25-MHz model.

the Atronic International motherboard is something of a chore, since it is three-quarters covered by the disk drives and power supply. The motherboard sports six 16-bit slots, two 8-bit slots, and a special cache-board slot. Three of the standard slots—including the two 8-bit slots—are covered by the power supply, so you should still have room for three half-length

Also on the motherboard is the Chips and Technologies chip for hard and floppy disk drives. The cache board, which is best thought of as an extension of the motherboard, has 32K of 35-nanosecond cache as tested, though it can be upgraded to 64K for \$100. Except for cache memory, the system uses SIMMs exclusively. With 1-megabit SIMMs, you can have up to 8MB on the board. You can also have up to 8MB more of 16-bit RAM if you add an appropriate memory board.

The SIMM sockets alternate with the card slots, so you have to remove the power supply to get at three of them. In addition, you have to remove the disk drive to get at the DIP switches under the drive. Also under the disk drives is the coprocessor socket for an 80387 or Weitek 3167. There's even a socket for an 80287 math chip, though it's hard to imagine why you would want to use one (and the manufacturer recommends against it).

The EGA Gas Plasma 386-c's performance on our benchmark tests was adequate. Results on the disk and video tests were decidedly worse than average; these were balanced by the processor and memory scores, revealing the system as solidly in the midrange among all systems, and one of the best among the 20-MHz machines we reviewed.

Ultimately, the Micro Telesis EGA Gas Plasma 386-c leaves the same overall impression as its benchmark test scores: adequate. It's a credible system with nothing terribly right or wrong about it. If you find the combination of features and price interesting, then by all means take a look, but look elsewhere as well.

NATIONAL MICRO SYSTEMS INC.

National Micro Systems Gas Plasma 386-25

by M. David Stone

If you look at the National Micro Systems Gas Plasma 386-25 right after looking at the similarly-named model from Micro Telesis, Yogi Berra's famous line about "déjà vu all over again" will likely come to mind. Both lunchboxes sport the same Portable PC III logo; in fact, if you put the two systems next to each other, you can't see any important difference. But the resemblance is only skin deep.

To begin with, this is a 25-MHz system, not 20-MHz; as you'd expect, it costs more. Its base price is \$3,499 and includes 1MB RAM, a Seagate 24-millisecond 40MB hard disk, a 1.2MB floppy disk drive, a serial and a parallel port, a CGA/Hercules display, and 64K cache memory. *PC Magazine's* standard configuration needs only 1MB RAM and DOS added, for a total price of \$3,749. As tested, the system included 4MB RAM, a CDD 80MB hard disk, an 80387-25, and a price tag of \$5,048.

The display on the Gas Plasma 386-25 is one of the strongest features of the system. Unlike some other gas plasma screens (specifically the screen on the Micro Telesis system), this one—which is only CGA—is eminently readable, with good brightness and contrast. According to a National Micro Systems representative, the screen is part of the OEM'd case, but there are different screens for CGA and

The Micro Telesis keyboard's layout is based on the original AT, which means that the keys are in different positions than on the 101-key Enhanced layout.

boards and two full-length boards.

The tested system had three slots filled with an 8-bit Prisma EGA MAX 860 video card, a Seagate disk controller card, and a serial/parallel card. Alas, the Prisma card is two cards thick, and it nearly covers a second slot. You can still shoehorn in a board, but it's guaranteed to touch. Micro Telesis will supply an insulating separator if you need to use the slot.



FACT FILE

National Micro Systems Gas Plasma 386-25
National Micro Systems Inc., 2833 Peterson Pl., Norcross, GA 30071, (404) 446-0520.
List Price: With 1MB RAM, 40MB hard disk, one 1.2MB 5.25-inch floppy disk drive, CGA gas plasma display, \$3,499; with 2MB RAM, DOS 3.3, GW BASIC, \$3,749; with 4MB RAM, 80MB hard disk, 80387-25 coprocessor, \$5,048.
In Short: This system offers a highly readable CGA gas plasma display, 25-MHz 386 performance, and a lunchbox luggage design. The keyboard has a good feel, though the layout may be confusing if you're used to the Enhanced keyboard. Graphics software users, look elsewhere.

CIRCLE 418 ON READER SERVICE CARD



The National Micro Systems Gas Plasma 386-25 offers a CGA display combined with 25-MHz 386 performance. Graphics users will suffer trying to use this \$3,749 lunchbox, which comes with 2MB RAM, a 40MB hard disk, a 1.2MB floppy disk drive, and DOS 3.3.

EGA versions. National Micro Systems doesn't sell the EGA version.

The Gas Plasma 386-25 keyboard is identical to the one that comes with the Micro Telesis system, with the same audible click and solid kinesthetic feedback. Since they both use the same cases, the basic physical design is also identical, with the screen defining the front of the same 9.1-by-16.1-by-8.2-inch case. One minor difference is that the National Micro Systems computer is about half a pound lighter—23 pounds on PC Labs' digital scale.

One of the Gas Plasma 386-25's strengths is its eminently readable display.

Other physical details also match. In particular, getting to the motherboard is something of a chore, since it is three-fourths hidden by the disk drives and power supply. But once you get that far you'll find an entirely different motherboard.

The Gas Plasma 386-25 is built around an AMI motherboard. The board offers eight slots: one 8-bit, six 16-bit, and one 32-bit, but three slots are covered by the power supply. As a result, only five are available: three 16-bit slots, one 8-bit, and one 32-bit, providing room for two half-length and three full-length boards.

One of the "available" full-length slots

is actually used by a dedicated 32-bit memory board. All RAM is on the board, using 80-nanosecond DIP-type DRAMs. Fully populated, the board will hold 8MB. The only memory on the motherboard is cache—64K of 25-ns. cache in the tested unit. Also on the motherboard is the Chips and Technologies chip set, the AMI BIOS, and an 80387.

According to a National Micro Systems representative, the Orchid video card in the unit is available only with the Portable PC III case and therefore has no model name. It supports CGA and Hercules. The card has a DB-9 connector on the back for an external monitor.

In addition to the video card, memory board, and parallel/serial card, the system included a Western Digital disk controller with an ST-506-compatible interface. The boards fill four of the five available slots, leaving room for a half-length card—most likely a modem or network card, if you can fit it among all the cables.

Performance on our benchmark tests varied from better than average (for processor and memory tests) to far worse than average (for the video tests). Disk performance was particularly uneven. For real-world applications, the Gas Plasma 386-25 is generally good enough.

Alas, "good enough" is small praise for a computer that can cost more than \$5,000. If you must have a 386 luggable and you insist on a highly readable text screen, the National Micro Systems Gas Plasma 386-25 is certainly worth your attention. If you use graphics software, it's not. This is not a machine to get excited about or to recommend unreservedly.

PAN UNITED CORP.

Micro Labs 386/20 L

by Bruce Brown

Flimsiness is the last thing you want in a high-powered portable. Unlike some of its competitors, the Micro Labs 386/20 L is solidly built. Like the other Micro Labs machines we've reviewed in the past, the two-tone gray 386/20 L puts an emphasis on standard component parts at good prices.

The base-system 386/20 L costs \$3,696 and includes 1MB of RAM, a 20MB 40-millisecond Seagate ST-125 hard disk, a 1.44MB floppy disk drive, a gas plasma VGA display, one serial and one parallel port, various utility programs, and a nylon carrying case. In our standard configuration with 2MB of RAM, a 40MB hard disk, and DOS 3.3, the system price rises to \$4,039.

The lunchbox-style 386/20 L has an FCC Class A rating with Class B rating pending. It measures 9.9 by 16.1 by 9 inches (HWD) and weighs 22.8 pounds. Its test scores were average for a 20-MHz

PC FACT FILE

Micro Labs 386-20 L
Pan United Corp., 1967 Route 27, #12, Edison, NJ 08817; (800) 433-3006, (201) 965-8009
List Price: With 1MB RAM, 20MB hard disk, one 1.44MB 3.5-inch floppy disk drive, VGA gas plasma display, utility software, \$3,696; with 43MB hard disk, \$3,846; with 2MB RAM, 40MB hard disk, DOS 3.3, \$4,039.
In Short: Pan United's Micro Labs 386-20 L is a 20-MHz computer with a comfortable keyboard, a standard VGA gas plasma display, and a 64K memory cache. This machine has the right components at a reasonable price.

CIRCLE 418 ON READER SERVICE CARD

transportable with memory caching. Its processor can be slowed to 8 MHz, while the expansion bus runs at a fixed 8 MHz. An AMI motherboard and BIOS are installed, with the Chips and Technologies 386 chip set. Both setup and system diagnostics are in ROM.

MEMORY ON A CARD

The motherboard has all user memory on a proprietary memory card, with 64K of 25-nanosecond cache memory on the system board. The 386/20 L doesn't use memory interleaving or RAM shadowing, relying

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The quality of the components and the design of Pan United's Micro Labs 386/20 L make it a worthy candidate for consideration. With 2MB RAM, a 40MB hard disk, and one 1.44MB floppy disk drive, the 20-MHz VGA system is a rather high \$4,039.

instead on memory caching for a performance edge. The single, dedicated 32-bit expansion slot, which runs at full system clock speed, handles all system memory. If you want more than 2MB of RAM, however, you must purchase the optional memory board, which uses 1-megabit chips and can hold up to 8MB of 32-bit RAM by itself, and up to 16MB with a daughterboard. Memory upgrades cost \$175 per megabyte of 100-ns. 256-kilobit chips. The optional memory board costs \$125, and the daughterboard costs \$95.

The system case has room for two 5.25-inch half-height drives and one 3.5-inch drive, each of which can hold storage devices with removable media. The test unit came with an NCL MFM floppy/hard disk controller.

The expansion slots include the 32-bit memory slot, three 16-bit slots, and one 8-bit slot. One 16-bit slot was empty in the test machine. There is no external floppy disk drive port and no provision for an external expansion chassis.

The 386/20 L keyboard has excellent feel and a comfortable flat area in the front that could serve as a palm rest. The non-standard layout provides 103 keys, with two rows of six function keys on the upper-left and a second cursor-control set on the upper-right side. The keyboard plugs into the left side of the case with a 24-inch cable, and it is replaceable with a standard AT keyboard.

The standard 16-bit VGA 16-gray-scale gas plasma screen has an orange-on-black appearance and is fine to work with, though I didn't think it was on a par with some of the other gas plasma displays. There's a control for brightness but none

for contrast, leaving the differentiation between foreground and background unexceptional and unchangeable. Maximum screen resolution is 640 by 480 pixels and the system supports VGA, EGA, CGA, HGA, and MDA modes, both internally and externally.

About half of Pan United's sales are through dealers, and the rest are mail-order. The standard warranty covers parts and labor for one year, with mirror shipping for machines repaired under warranty. Also included is a 30-day money-back guarantee and a toll-free support line.

The Pan United machine is a competent luggable computer. Everything performs up to expectations, except perhaps the display. This machine is not priced as aggressively as Pan United's desktop models tend to be, although certainly the 386/20 L is less expensive than big-name computers and roughly in line with similarly equipped mail-order machines. If the display is good enough for your needs and you need the room for an extra drive, the Micro Labs 386/20 L could be your 386-to-go.

PC BRAND INC. PC Brand 386/25 VGA Portable III

by Bruce Brown

PC Brand wants to build a computer especially for you. While the company sells preconfigured computers, its strength is custom configurations, including a variety of BIOS and motherboard combinations. "PC Brand 386/25 VGA Portable III" is

the full model designation for this computer, more than twice a mouthful. At 25.24 pounds, this FCC Class A-rated machine is one of the heaviest units in the test configuration. You won't find yourself running between air terminals with this 9.75-by 16.2-by 8.25-inch lunchbox.

The base configuration costs \$3,225 with 1MB of RAM, a 40MB 25-millisecond hard disk, a 1.44MB or 1.2MB floppy disk drive, a CGA-, HGA-, and MDA-compatible LCD, one serial and one parallel port, utilities, setup, and diagnostic software. Assembled with 2MB of RAM, the same 40MB hard disk, a VGA gas plasma display, and DOS 4.01, the price rises to \$4,000.

The VGA Portable III scored respectably on the PC Labs benchmark tests, with faster times than most on the disk tests due to its Adaptec caching drive controller. The unit's video scores were the best of the group, helped by PC Brand's 16-bit Trident VGA card.

The VGA Portable III is extremely flexible: the 25-MHz 80386 processor can run at 8 and 16 MHz; the expansion bus operates at 4, 8, 12.5, 16, or 25 MHz. The



FACT FILE

PC Brand 386/25 VGA Portable III
PC Brand Inc., 854 W. Washington, Chicago, IL 60607; (800) PC BRAND, (312) 226-3500.
List Price: With 1MB RAM, 40MB hard disk, one 1.2MB 5.25-inch or 1.44MB 3.5-inch floppy disk drive, CGA liquid crystal display, utilities, \$3,225; with 2MB RAM, VGA gas plasma display, DOS 4.01, \$4,000; with 8MB RAM, 150MB hard disk, 1.2MB and 1.44MB floppy disk drives, 80387-25 coprocessor, \$7,000.
In Short: The PC Brand 386/25 VGA Portable III is a highly customizable 25-MHz machine with lots of expansion possibilities. High on the list of considerations is PC Brand's five-year prorated system warranty. The downside of this computer is its 25-pounds-plus weight; you really need determination to take it very far.

CIRCLE 417 ON READER SERVICE CARD

AMI BIOS setup functions are in ROM, and the Chips and Technologies 386 chip set setup program is on-disk.

MANAGING MEMORY

All memory is on the motherboard; there was 8MB in the tested unit, and 16MB is the maximum. PC Brand has chosen not to use memory caching in this computer. The company contends that cache controllers generate too much heat for the transportable form factor.

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COVER STORY

386-BASED PORTABLES



At 25.24 pounds, the PC Brand 386/25 VGA Portable III is no lightweight. Complete with 2MB RAM, a 40MB hard disk, a high-density floppy disk drive, a VGA gas plasma display, and DOS 4.01, it costs only \$4,000.

The PC Brand machine does utilize memory interleaving. With the minimum 1MB of RAM installed the memory runs with one wait state, but with 2MB or more the effect is 0.5 wait states. Both ROM and video BIOS are shadowed in RAM, tying up the top 384K of the first 1MB of user RAM. Fortunately, if you have only 1MB of memory and don't care about the speed benefit of RAM shadowing, you can turn it off.

The VGA Portable III has more drive capacity than most portables, with space for two 5.25-inch half-height disk drives and one 3.5-inch drive. The test machine came with a 16-millisecond Miniscribe 150MB ESDI hard disk and both a 1.2MB and a 1.44MB floppy disk drive, but you could replace one of the floppy drives with a second hard disk or perhaps a tape backup device.

Like many AC-powered lunchbox portables, the VGA Portable III machine uses a motherboard also used in desktop computers. As usual, the compactness of design eliminates several of the motherboard's open slots. Here, three expansion slots are blocked by the 180-watt power supply. Four 16-bit and one 8-bit slot are accessible, with two 16-bit slots free in the test configuration.

The 86-key keyboard has twelve function keys across the top but is otherwise similar to the original AT keyboard, and the feel is excellent. When you unhook it from the closed system you need to be careful, because there's not much of a ridge for the keyboard to rest on and it falls easily.

The very fast 16-shade gray-scale VGA

gas plasma display has good contrast and resolution, with a brightness control but no lever for adjusting the contrast. One of PC Brand's major features is video flexibility. If you want to use a special VGA card for specific applications, a "feature connector" on the top of the video card allows you to attach your own card for internal display resolution up to 640 by 480 pixels, or you can run an external monitor to the resolution limits of your chosen card and monitor.

PC Brand supports many options as part of its customization policy. You can use either an 80387-25 or a Weitek math coprocessor chip, or both, by means of an optional adapter. A 1,200-bit-per-second Hayes-compatible modem costs \$49, while 2,400 bps sets you back only \$79. A Cordura carrying case is only \$45. PC Brand sells a 40MB internal tape backup unit for \$220 and a 150MB tape unit for \$760. For the same \$760 price you can buy an internal CD-ROM player as well. It's not a bad grocery list.

PC Brand's service and support policies are particularly good, including a standard five-year prorated system warranty and a 30-day money-back guarantee. For warranty service PC Brand pays ground shipping both ways. PC Brand currently sells 80 percent of its computers directly; the rest are sold by dealers and value-added resellers.

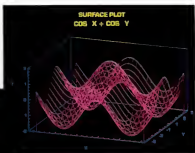
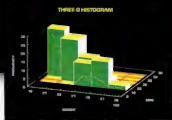
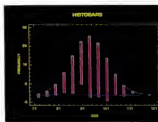
The PC Brand lunchbox is heavy, but it packs a lot of power and admirable expandability. The warranty and return policies are especially generous. And the bang-for-the-buck ratio is very high, with excellent high-powered performance.

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CIRCLE 368 ON READER SERVICE CARD

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BENCHMARK TESTS: 386-BASED PORTABLES

The Dolch P.A.C. 386-25C emerges as the fastest 386 transportable on our benchmark tests, with four first- and two second-place finishes, while the PC Brand 386/25 VGA

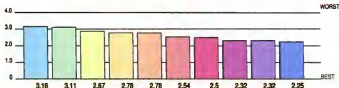
Portable III has the quickest video performance among the 25-MHz machines. In the 20-MHz field, Toshiba's TS200 edges past the Compaq Portable 386 and the Micro Teleis EGA Gas Plasma 386-c.

PROCESSOR AND MEMORY BENCHMARK TESTS

80386 Instruction Mix

Elapsed Time (seconds)

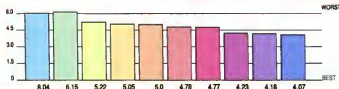
The 80386 Instruction Mix benchmark test times a series of tasks specific to the 80386 chip. Since this test shows how the CPU operates in the context of the bus, processor, system memory, and motherboard architecture, a faster time means better overall computer performance.



Floating-Point Calculation Without Coprocessor

Elapsed Time (seconds)

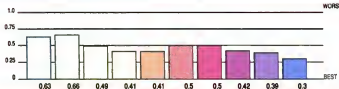
The Floating-Point Calculation Without Coprocessor benchmark test sets up a floating-point emulation program in RAM and then exercises the processor and tests RAM access speeds during floating-point calculations.



Conventional Memory

Elapsed Time (seconds)

The Conventional Memory benchmark test measures the read/write speed of the first 640K of memory. Slower relative times can indicate the presence of memory wait states or memory chips rated at slower access speeds.

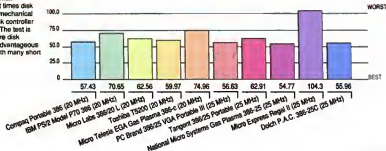


DISK BENCHMARK TESTS

DOS File Access (Small Records)

Elapsed Time (seconds)

The DOS File Access (Small Records) benchmark test times disk throughput as a result of mechanical disk drive speed, hard disk controller function, and bus speed. The test is performed without software disk caching. Fast times are advantageous for programs that work with many short segments of data.



CONTINUES

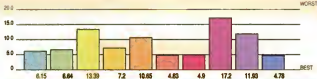


BENCHMARK TESTS: 386-BASED PORTABLES

DOS File Access (Large Records)

Elapsed Time (seconds)

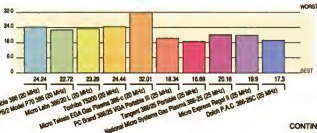
The DOS File Access (Large Records) benchmark test times disk throughput as a result of mechanical disk drive speed, hard disk controller function, and bus speed. This test minimizes the effect of small hardware caches on disk subsystem performance. It is performed without software disk caching. Fast times are advantageous when large files are loaded.



BIOS Disk Seek

Elapsed Time (milliseconds)

The BIOS Disk Seek benchmark test measures mechanical back-to-track disk drive access times. Fast times are helpful with programs such as databases, which often store and must later find data in many separate places on a drive.



CONTINUES

32 BIT ACCESSORIES!

MicroWay is your best source for the software and hardware you need to get true 32-bit performance from your 386. Our NDP C compiler takes the original C concept of writing lower level code with a higher level language to the limit. We provide an inline assembly language interface that lets the programmer specify the exact register used to hold a variable. This feature makes it possible to use ports or perform interrupts or block moves inline, instead of through calls. The use of register aliased variables to control hardware reduces the size of critical code sequences by a factor of 3 to 10 and keeps the 386's pipelines full by eliminating costly calls. If you are interfacing DOS or the ROM BIOS, writing graphics routines, an operating system

kernel, a device driver, or an embedded application, you owe it to yourself to try NDP C-386.

NDP C is also the language of choice if you are combining C with FORTRAN or Pascal, are planning to use any one of four coprocessors that run with the 80387, or require the best globally optimized code attainable. MicroWay's C, FORTRAN and Pascal compilers come with a 70 function device-independent graphics library that automatically supports Monochrome Hercules, CGA, EGA, and VGA adapters and makes it easy to interface memory mapped peripherals such as digitizers or serial devices. Finally, our C is not only one of the easiest to use, but supports two dialects: ANSI and UNIX. Ithaca Software reports: "We ported HOCOPS with over 100,000 lines, without a hitch in less than a day! NDP C-386 was the fastest 386 compiler we used. It also offers the enormous advantage of Wattec support."

386 Compilers and Tools

NDP C++ is a MicroWay port of the UNIX C++ preprocessor version 1.2. It runs in protected mode on DOS, UNIX or XENIX, and is ideal for writing numerics and graphics applications. The product comes with an example of how to support complex numbers in C++ \$495

NDP Fortran-386™, NDP C-386™, and NDP Pascal-386™ compilers generate globally optimized, mainframe quality code that runs on the 386 or 486 in protected mode under UNIX, XENIX or Phar Lap extended DOS. The compilers address 4 gigabytes of memory while supporting the 80287, 80387 and Wattec coprocessors. Applications can mix code from all three compilers and assembly language. The DOS versions allow the user to write his own numeric error handlers and interface 386 real mode programs from protected mode. The VM versions use Phar Lap's Virtual Memory Manager to run programs which exceed the size of your system memory. NDP Fortran-386 is a full FORTRAN 77 with FORTRAN 66, BSD 4.2, DOD and VMS extensions. NDP C-386 is a full K&R C with both MS and ANSI extensions. It is 100% compatible with UNIX C and is substantially faster than the C which comes with UNIX. NDP Pascal-386 is a full ANSI/IEEE Pascal, with extensions from C and BSD 4.2 Pascal.

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 VM version (requires VMM) ... \$695
 UNIX/XENIX versions ... \$795
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 Phar Lap Memory Manager (VMM) ... \$295
 NDP Windows™ Library \$125, C Source \$250
 NDP HOCOPS™ ... \$575
 NDP Plot™ ... \$325
 NDP/FFT™ 80x87 or NDP ... each \$250
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CIRCLE 256 ON READER SERVICE CARD



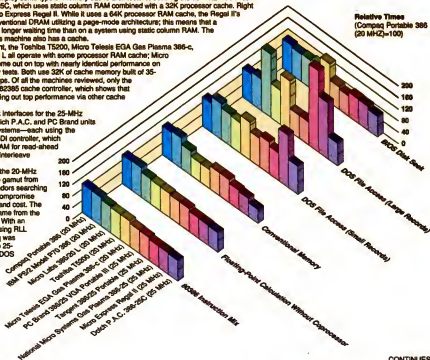
PROCESSOR, MEMORY, AND DISK BENCHMARK TESTS: COMPOSITE VIEW

The presence or absence of a RAM cache is the primary determinant of these machines' processor performance. Three out of five 25-MHz machines and three of the five 20-MHz machines employ some type of memory cache architecture. Leading the 25-MHz machines is the Deich P.A.C., which uses static column RAM combined with a 32K processor cache. Right behind comes the Micro Express Regal II. While it uses a 64K processor RAM cache, the Regal II's system memory is conventional DRAM utilizing a page-mode architecture; this means that a cache miss results in a longer waiting time than on a system using static column RAM. The National Micro Systems machine also has a cache.

On the 20-MHz front, the Toshiba T5200, Micro Teleis EGA Gas Plasma 386-C, and Micro Labs 386/20 L all operate with some processor RAM cache; Micro Teleis and Toshiba come out on top with nearly identical performance on processor and memory tests. Both use 32K of cache memory built of 35-nanosecond SRAM chips. Of all the machines reviewed, only the Toshiba uses the Intel 82385 cache controller, which shows that most vendors are seeking out top performance via other cache methods.

ESDI rules the disk interfaces for the 25-MHz transportables. The Deich P.A.C. and PC Brand units had the fastest disk systems—each using the Adaptec ACB-2322 ESDI controller, which possesses on-board RAM for read-ahead caching as well as 1:1 interleave support.

Disk technology in the 20-MHz transportables runs the gamut from MFM to SCSI, with vendors searching for the most effective compromise between performance and cost. The best overall showing came from the Compaq Portable 386. With an embedded controller using RLL encoding, this Compaq was faster than some of the 25-MHz machines on the DOS File Access tests.





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80386-33**

- Intel 80386-33 CPU with 4MB of RAM expandable to 16MB of 32-bit memory.
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- 1.2 or 1.44MB floppy drive.
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- Expansion slots: 5 16-bit and 2 8-bit slots.
- 270W power supply.
- 16-bit VGA adapter w/512K, 1024 x 768 resolution.
- NEC Multisync 3D monitor.
- Options include hard disks from 20MB to 300MB, tape backup, modem, mouse, Wordperfect key caps, DOS, extra floppy, monitors, game card, coprocessor and tower case.
- **\$4314**
- Prices start at \$3145 for mono system with 1MB.

SX Power at a 286 Price



80386SX-16

- Intel 80386SX 16MHz CPU (Norton SI ver 4.0: 16).
- 1MB RAM standard, expandable to 8MB on motherboard.
- 80387SX coprocessor socket
- EMS 4.0 software drivers.
- Expansion slots: 4 16-bit and 2 8-bit slots.
- 1.2 or 1.44MB diskette drive.
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- Open architecture design allows the user to upgrade the system from a 386SX-16 to a 386-20 merely by purchasing a new CPU card. This lets you keep all of your options open for the future.
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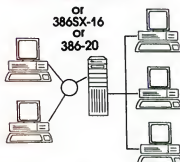


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DATA 386-20

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- NEC Multisync 3D capable of 1024x768 Interlaced
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- 1.2MB or 1.44MB drive
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DATA 386-25

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- 1MB base RAM, expandable to 16 MB of 32-bit memory
- LIM EMS 4.0 driver supplied
- Intel 82385 cache controller 64K of static RAM cache (2-way set associative)
- 16-bit extended VGA card, 512K capable of 1024x768 with 16 colors
- NEC Multisync 3D capable of 1024x768 Interlaced
- 1.2MB or 1.44MB drive
- 1 32-bit, 5 16-bit, and 2 8-bit
- 230W power supply
- 1 parallel and 2 serial ports

AVAILABLE OPTIONS

- Full-size vertical case
- RAM upgrades to 2, 4, 5, or 8MB using DIPs and/or SIMMs
- 20MB to 300MB hard drives with MFM, RLL, SCSI, or ESDI interface
- 40-120MB tape backup drive
- Available in standard monochrome (720x348, amber), standard VGA (640x480, color) or extended VGA (800x600 up to 1024x768, color)

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BASE CONFIGURATION W/40MB DRIVE (VGA GAS PLASMA)

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- 1MB of base RAM, expandable to 5MB with memory daughterboard
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- 40MB, 25ms hard drive (IDE interface)
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MARCH 7, 1989

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INFOWORLD
AUGUST, 1989

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LOS ANGELES TIMES
NOVEMBER 24, 1988

"If it sounds like we're raving about this machine we are."

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GUIDE, 1989

"... It's hard to imagine a better choice."

PC WORLD,
JUNE, 1989

"Using a HeadStart III is almost as easy as plugging it in."

COMPUTER WORLD
MAGAZINE, MAY, 1989

SPECIFICATIONS

MICROPROCESSOR: Intel 80286-12
SPEED: 12MHz/8 Switchable
RIB: Award
BUILT IN RAM: 1 Megabyte
EXPANDABLE TO: 3 megabytes
POWER SUPPLY: 145 watts
110/220 switchable
KEYBOARD: 101 key PS/2 compatible
GRAPHICS: VGA Automatic
FLOPPY DRIVES: one 5.25" 1.2 megabyte, one 3.5" 1.44 megabyte
HARD DRIVE: 32.1 megabyte, 28 megabyte, 1.1 megabyte
BUILT IN INTERFACES: Parallel, 2 RS232 serial, mouse, joystick
EXPANSION SLOTS: 3 available
SOFTWARE: DOS 3.3, GW Basic, HeadStart Advanced Environment, Floppy Drive Emulation II, 3-D Graphics, All and Computer Ease Tutorial Software, Xtree hard disk manager, Publish-it! Chessmaster 2000, Splash, VGA paint program, Bookmark, plus Twist and Shout.



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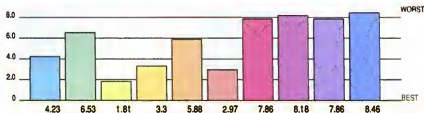
BENCHMARK TESTS: 386-BASED PORTABLES

VIDEO BENCHMARK TESTS

Direct to Screen

Elapsed Time (seconds)

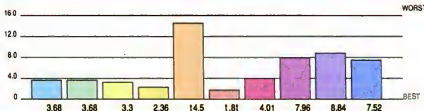
The Direct to Screen benchmark test indicates the speed of the video adapter memory. Good scores indicate that information can get to the screen quickly, particularly for programs that avoid the computer's BIOS and go directly to the screen.



Video BIOS Routine with Scrolling

Elapsed Time (seconds)

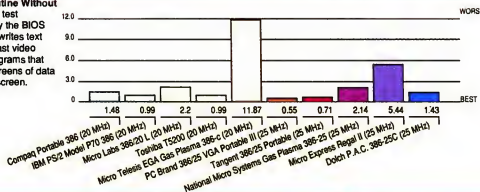
The Video BIOS Routine with Scrolling benchmark test measures how fast the video adapter can scroll the screen, moving the display up one line at a time. Good performance is helpful for scrolling through word processing or spreadsheet files.



Video BIOS Routine Without Scrolling

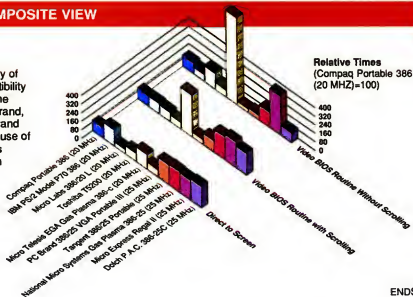
Elapsed Time (seconds)

The Video BIOS Routine Without Scrolling benchmark test measures how quickly the BIOS on the video adapter writes text data to the screen. Fast video writing helps with programs that show full or partial screens of data without scrolling the screen.



VIDEO BENCHMARK TESTS: COMPOSITE VIEW

Video performance varies greatly, thanks to the diversity of display adapters found in these machines. The compatibility ranges from double-scan CGA in the Dolch machine (the display is electroluminescent) to VGA in the IBM, PC Brand, and Toshiba unit (all of which are gas plasma). PC Brand and Toshiba had the fastest display times, largely because of their 16-bit interfaces with the computer. All video tests were run with video BIOS shadowing enabled except in the case of the Micro Telesis transportable, which does not offer this feature.



ENDS



The Tangent 386/25 Portable offers solid 25-MHz performance at a reasonable \$3,528 for a system with 2MB RAM, a 40MB hard disk, a 1.44MB floppy disk drive, EGA gas plasma display, and DOS.

ROM. The system CPU is an Intel 80386-25, which can run at 8, 12.5, or 25 MHz using 16- and 50-MHz crystals on the motherboard; the expansion bus can be set to run at 8, 8.3, or 12.5 MHz.

The Tangent's motherboard can hold up to 8MB of 80-nanosecond SIP DRAM chips, and it uses memory interleaving with 2MB or more of memory. With 1MB, the memory runs at one wait state, while with 2MB or more the speed is equivalent to just 0.5 wait states.

Memory upgrades cost \$225 per megabyte. For those who want more than 8MB, the unpopulated memory expansion card

ed to hooking up an external 5.25-inch 1.2MB floppy disk drive to the back of the machine via a standard external port; this is a \$109 option. Other system expansion is done through the expansion slots. There are eight in all, but three are blocked by the power supply. The accessible slots include three 16-bit slots and two dual-identity slots that can use either 8-bit or 32-bit cards.

The Tangent test machine has a Suntek Information International EGA board to run the standard gas plasma display. This video combination can handle EGA-, CGA-, and MDA-compatible video signals; it gives you amber characters on a black background. The screen quality is very good. Brightness and contrast controls are on the bottom-right side of the screen.

Tangent's selection of internal modems is particularly notable. A Hayes-compatible 2,400-bit-per-second model is available for \$139, a Telebit 9,600-bps high-speed modem for \$790, a Microcom QX3296 19,000-bps MNP unit for \$1,190, and a Microcom QX V.32 with Hayes 2,400-bps compatibility (as well as MNP compression for throughput of up to 30,000 bps) for \$1,590.

Tangent Computer has been in business since December 1988. Its sales channels include direct mail order and sales through VARs and a few dealers. Tangent computers come with a one-year parts-and-labor warranty. The 30-day money-back guarantee might ease some concerns about dealing with a new company.

The Tangent lunchbox model works well and is priced competitively for a mail-

order computer. Its only uncommon component is its Data Expert motherboard, which functioned well during our testing. If you can live without memory caching but you do need 25-MHz 386 performance, the Tangent 386/25 Portable might be just right.

TOSHIBA AMERICA INFORMATION SYSTEMS INC.

Toshiba T5200

by Bruce Brown

Toshiba's T5200 is an admirable flagship for the company's full line of laptop machines. This comparatively lightweight, high-powered computer looks good, runs fast, and has plenty of expansion possibilities. Toshiba's leadership role in laptop computers is further enhanced by this classy machine, the only clamshell-type entry in the present line-up.

The 20-MHz Toshiba T5200 is available in two models, the T5200/40 and the T5200/100, with 40MB and 100MB hard disks, respectively. Toshiba uses Conner hard disks with a proprietary Conner drive controller and interface system. Both models are Class B-rated by the FCC. With 2MB RAM, a 1.44MB 3.5-inch floppy disk drive, a gas plasma VGA display, two serial and one parallel port, DOS 3.3, Quarterdeck Office Systems' *QEMM* memory management software, a disk caching utility, and on-line system documentation, the T5200/40 lists for \$7,699. The T5200/100 sells for \$8,299 with 2MB of RAM. The evaluation unit has 4MB of

The Tangent lunchbox works well and is priced competitively even for mail order.

costs \$145. Tangent sells three math co-processor chips for this machine: the Intel 80387-20 for \$425, the Intel 80387-25 for \$525, and the Weitek 3167 for \$1,295. The system also lets you choose to shadow video or ROM BIOS, or both. No extended-memory drivers are included with the standard system, but Tangent sells two different programs, *386-to-the-Max* and *386/SYS*, for \$29 each. There is no RAM cache.

If you want to add a drive, you're limit-



Toshiba T5200

Toshiba America Information Systems Inc., Computer Systems Division, 9740 Irvine Blvd., Irvine, CA 92718; (800) 457-7777, (714) 583-3000.

List Price: Model T5200/40: with 2MB RAM, 40MB hard disk, one 1.44MB 3.5-inch floppy disk drive, VGA gas plasma display, DOS 3.3, utilities, \$7,699; Model T5200/100: with 100MB hard disk, \$8,299; with 4MB RAM, \$9,298. In Short: The Toshiba T5200 is the best-looking and lightest of the five machines I reviewed, even with its 100MB hard disk. This machine is available only through dealers, and street prices are often reduced by at least one-third of the list price. It's a worthy candidate from one of the companies that continues to write the portable computing book.

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EDITOR'S CHOICE

• Dolch P.A.C. 386-25C

Among the 20- and 25-MHz 386 AC-only portables reviewed here, the majority stood out by not standing out. Most cases are knock-offs of the Compaq Portable III, and fit and finish aren't up to snuff. The machines that truly stand out are from Toshiba, IBM, and Dolch. The Dolch is the best of them.

Dolch Computer Systems just keeps topping itself. The Dolch P.A.C. 386-20C was our Editor's Choice the last time we reviewed 386 portables (*PC Magazine*, October 11, 1988). This year, though the field grew dramatically, Dolch maintained its edge. The Dolch P.A.C. 386-25C offers everything a transportable should: power, expandability, and dependability. On our tests, its 25-MHz processor simply outclasses its competitors. Its three open 16-bit slots provide ample room for expansion. And it is sturdy and solid.

Outfitted with a VGA display (the double-scan, electroluminescent CGA display on the version we tested is sharp, but VGA is well worth an extra \$595), a Dolch P.A.C. 386-25C with 2MB RAM, a 40MB hard disk, one 1.2MB floppy disk drive, and DOS costs \$8,145. That's expensive—but less than you would have to pay for a less powerful and less expandable 20-MHz Compaq Portable 386.

Two 20-MHz portables deserve honorable mention: the Toshiba T5200 and the IBM PS/2 Model P70 386. The 19.5-pound T5200 is the only clamshell-type model in this line-up, and its performance puts it in the front rank of 20-MHz portables, thanks largely to its 32K memory cache. For \$7,699, you get 2MB RAM, a 40MB hard disk, a 1.44MB floppy disk drive, two internal slots, and a bright VGA gas plasma display that ranks with that of IBM's Model P70 386.

Besides the impressive screen, the IBM unit (\$7,695) gives you 4MB RAM, a 60MB hard disk, a 1.44MB floppy disk drive, and two MCA slots, one of which is 32-bit.



The Toshiba T5200 is the only clamshell-type unit in this roundup. This 20-MHz portable comes with 2MB RAM, a 40MB hard disk, a 1.44MB floppy disk drive, VGA gas plasma display, DOS 3.3, and utilities for \$7,699.

RAM and a \$9,298 list price.

As configured, the T5200/100 weighed 19.5 pounds on PC Labs' digital scale, making it the lightest of this heavy bunch. The case measures 3.9 by 14.6 by 15.6 inches (HWD). The AC-only Toshiba is a laptop by design, but unless you've got a strong lap, with its size and weight it's more suitable for use on a desk.

Though only a 20-MHz computer, the Toshiba is the fastest of the 20-MHz machines in this review. In fact, several of its benchmark test scores, including the Conventional Memory timing, were better than those of some of the 25-MHz machines we tested. The bottom line is that the T5200 is very fast.

ON THE INSIDE

The system can run at 8 or 20 MHz, while the expansion bus can be configured to run at 8, 10, or 20 MHz. Toshiba makes its own motherboard and 386 chip set and uses a ROM BIOS developed in conjunction with Award.

The T5200 comes with 2MB of 32-bit memory standard, upgradable in 2MB increments to a maximum of 8MB of 32-bit memory without an additional memory board. Once 4-megabit chips become available, this machine will be able to expand to 26MB total RAM—the base 2MB plus three 8MB modules. The 32K of static RAM cache memory uses 35-nanosecond chips and an Intel 82385 cache controller. The Toshiba does not use memory interleaving but does provide for user-selectable video and ROM BIOS shadowing in RAM.

Memory upgrades cost \$999 per 2MB increment, which is an unacceptably

high price in the light of current memory chip costs. Also, the T5200 will take an 80387-20 coprocessor chip, but Toshiba doesn't sell them.

The T5200 has two expansion slots, one a full-length AT-standard 16-bit slot and the other a dual-identity half-length slot that can hold either an XT-standard 8-bit or a 16-bit proprietary Toshiba board. Unlike some of Toshiba's other laptop computers, this one has no special modem slot. Toshiba sells a 2,400-bit-per-second Hayes-compatible internal modem card for \$399. If you need to add more cards and can live with 8-bit slots, you can configure the half-length slot as a Toshiba slot and install an expansion chassis interface card (\$199), to which you can attach a \$999 expansion chassis with five standard 8-bit slots.

The standard ports include two 9-pin serial ports, a 15-pin external monitor port, and a 25-pin port that can be configured either as a parallel printer port or as a port for an external disk drive. Toshiba sells a pricey \$499 5.25-inch 360K floppy disk drive that attaches to this port.

The 91-key keyboard has a good, silky feel, in a pleasing layout resembling that of the original PC-XT but with its twelve function keys across the top, AT-style. There is a full set of numeric-keypad/cursor-control keys on the right side of the keyboard. Unlike the situation with the lunchbox units, the T5200's keyboard is not removable.

The display screen is a 16-shade grayscale, 640-by-480-resolution VGA gas plasma display, with amber characters on a black background. The screen can easily be detached by removing just two screws.



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The Toshiba T5200 is the fastest of the 20-MHz machines in this review. In fact, several of its benchmark test scores were better than those of some 25-MHz machines.

Kellyn Betts is an associate editor of PC Magazine. Bruce Brown is a computer consultant based in Simsbury, Connecticut, and a frequent contributor to PC Magazine. Mary Kathleen Flynn is an associate editor of PC Magazine. Bill Howard is an executive editor of PC Magazine. Edward Mendelson is a contributing editor of PC Magazine. M. David Stone is a contributing editor of PC Magazine and an industry consultant specializing in communications.

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VGA/Mono	\$1402	\$1627	\$1767	\$1867	
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Video	1:1 RLL	1:1 RLL	1:1 MFM	1:1 RLL	1:1 ESDI	1:1 ESDI	1:1 ESDI	1:1 ESDI	1:1 ESDI
Mono	\$1407	\$1632	\$1737	\$1862	\$2357	\$2817			
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Video	1:1 RLL	1:1 RLL	1:1 MFM	1:1 RLL	1:1 ESDI	1:1 ESDI	1:1 ESDI	1:1 ESDI	1:1 ESDI
Mono	\$1507	\$1732	\$1837	\$1962	\$2457	\$2917			
VGA/Mono	\$1702	\$1927	\$2032	\$2157	\$2652	\$3112			
EGA	\$1847	\$2072	\$2177	\$2302	\$2797	\$3257			
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Mono	\$2182	\$2332	\$2462	\$2592	\$3162	\$3412	
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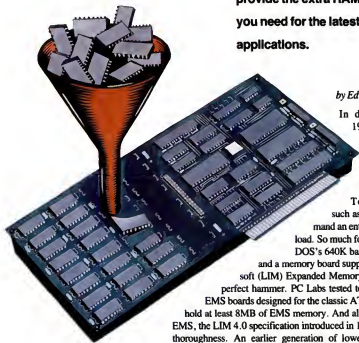
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A Slot Full of RAM

If your 286 is eating up memory like potato chips, these LIM EMS 4.0 memory boards can provide the extra RAM you need for the latest memory-hungry applications.



by Edward Mendelson

In dinosaur days—back in 1981—computer designers thought that 640K of memory was a monstrous amount. In fact, they thought that 128K was a monstrous amount.

Today, single applications such as *Lotus 1-2-3*, Release 3, demand an entire megabyte of RAM just to load. So much for foresight.

DOS's 640K barrier was made to be broken, and a memory board supporting the Lotus/Intel/Microsoft (LIM) Expanded Memory Specification (EMS) is the perfect hammer. PC Labs tested ten of the latest generation of EMS boards designed for the classic AT bus. All of these boards can hold at least 8MB of EMS memory. And all support the latest version of EMS, the LIM 4.0 specification introduced in 1987, with varying degrees of thoroughness. An earlier generation of lower-capacity 80286 EMS 4.0 boards, many of which are still available, were reviewed in the October 11, 1988, issue of *PC Magazine* ("Leveraging RAM with LIM 4.0").

Expanded memory provides the only way to bypass the 640K ceiling of all classes of personal computer, from workhorses driven by the humble 8088 to 486 thoroughbreds. 8088 and 80286 machines normally need special EMS-equipped memory-expansion boards to implement EMS. However, software can also be used to emulate expanded memory in the extended memory that 286 machines have, if you're willing to accept reduced speed. One such emulator is Douglas Boling's EMS40.SYS, available on PC MagNet. More sophisticated 386 and 486 machines don't need special EMS boards, but use the memory on the motherboard or any expansion card for EMS.

HISTORY OF RAM 101

To understand what an EMS board can and can't do, it helps to know the history of the various assaults that programmers have made against DOS's 640K wall. This limit seemed sensible and generous when IBM established it in 1981. The 8088 microprocessor used in the original PC and XT can directly recognize only 1MB (1,024K) of memory. IBM allocated the lower 640K of that megabyte for the RAM used by the operating system and application programs, and it reserved the upper 384K for the various ROMs used by the computer itself and its hardware options. The upper memory also served the video cards and the "cassette BASIC" ROMs that IBM put into its computers so that you could do something with the machine even if you lacked a disk drive.

It's the lower region of the upper 384K that marks the normal upper limit of DOS. Because this region is normally used only by EGA and VGA adapters, it's sometimes possible for monochrome or CGA systems to borrow a few more kilobytes to add to the DOS region by performing special tricks with hardware or software. Even VGA and EGA users can sometimes borrow those extra kilobytes if they're willing to give up high-resolution graphics. (See the sidebar "736K DOS for the Price of a Phone Call.")

TAKE THE LONG WAY HOME

The video solution isn't available to everyone, and it doesn't make much of a dent in the 640K barrier. So instead of trying to push through the barrier, programmers and computer designers have found ways around it. The first alternative route to more memory was taken in 1983, when IBM introduced the PC AT. The AT's

80286 chip addressed up to 16MB of memory, and any extended memory installed above 1MB could be used for RAMdisks and similar utilities. None of this memory, however, was available to applications, since it could be addressed only by putting the 286 processor in protected mode, and there were no applications that could work in protected mode at that time. As a result, this memory went to waste.

Next, in 1985, the LIM EMS allowed specially written software to swap data in and out of DOS's 640K while normally storing that data in a special region available equally to 8088 and 80286 machines—and now to 80386 machines. (In

To understand what an EMS board can and can't do, it helps to know the history of the various assaults programmers have made against DOS's 640K wall since 1981.

fact, Tall Tree Systems introduced a comparable memory-swapping scheme on its original JRAM boards, but the Tall Tree specification never caught on; the LIM spec, on the other hand, spread like wildfire.)

The original EMS specification announced in 1985, EMS 3.0, allowed you to use up to 8MB of expanded memory, usually in the form of RAM on special EMS expansion boards. EMS-aware applications like *1-2-3*, Release 2.0, could use that extra memory to keep large spreadsheets in RAM. And even if your applications knew nothing about EMS, you could still use all that extra memory for a RAMdisk, print spooler, and disk cache. But no one ever used EMS 3.0. It was quickly superseded by EMS 3.2, which took over an otherwise-unused 64K

region of the upper 384K and used it as a window for accessing information—up to four 16K pages worth—in expanded memory, giving applications more data space. An Enhanced EMS specification (EEMS) created by AST Research, Quadram Corp., and Ashton-Tate incorporated EMS 3.2 but increased its flexibility by allowing operating environments like *Microsoft Windows* and *DESQview* to use expanded memory for multitasking. The EEMS specification allowed the entire 1,024K address range—including both conventional and protected memory—to be passed through 16K pages. It also added support for two mapping registers.

Finally, in 1987, Lotus, Intel, and Microsoft introduced the LIM 4.0 specification, which incorporated virtually all of the features of EEMS and added more. Most notably, LIM 4.0 adds support for up to 32 mapping registers and gives programs the ability to access up to 32MB of RAM.

THE SOFTWARE SOLUTION

As the LIM EMS 4.0 specification developed, so did other means of cracking 640K. One obvious way of breaking the DOS barrier is OS/2. Although there is no RAM barrier for OS/2; the EMS drivers supplied with some of the boards in this survey allow you to use expanded memory in the DOS compatibility box under OS/2.

Another tool for bypassing the 640K constraint—short of installing OS/2—is a "DOS extender" of the type used by programs like *1-2-3*, Release 3, and the *IBM Interleaf Publisher*. DOS extenders, which use AT-style extended memory rather than LIM expanded memory, are built into individual DOS applications designed to be run on 80286 or 80386 computers, and they allow the application to work in the multiple megabytes as if the 640K wall were merely a mirage. DOS extenders affect only the programs that incorporate them; they can't extend DOS for any other programs you may favor.

If you've already sprung for expensive extended memory, you can use expanded-memory emulators to configure your AT's extended memory to LIM EMS 4.0. But while this software will give you the extra space you need for your *1-2-3* spreadsheets, only a LIM 4.0 board will give you such features as alternate hardware registers to allow fast task-hardware switching under multitasking environments. (For a discussion of packages that make the most of your RAM investment, consult "EMS

THE OUTLOOK FOR MEMORY: More RAM for Fewer Dollars

by Edward Mendelson

After the drought, the flood.

The days when memory cost \$500 a megabyte—that is, if you could find someone who could sell you the chips—are finally over. Although it



still isn't cheap to outfit a computer with the 8MB that you'll need before you can do anything useful with OS/2, the sting is a lot less painful. In the summer of 1989 you could buy mail-order RAM for as little as \$150 per megabyte. Barring other natural disasters, that price should continue to fall gradually over the course of the next few months.

Cheaper RAM means more room for large documents in expanded memory; more room for disk caches, print spoolers, and RAMdisks; and more speed and flexibility for multitasking operating environments like *Microsoft Windows* and *DESQview*. It also means that the most popular topic of conversation at the 1988 Comdex shows is now passé.

While prices have changed, the composition of the RAM market hasn't. The memory chip arena remains dominated by the Japanese giants Hitachi, Toshiba, Matsushita, Fujitsu, and NEC.

IBM makes huge quantities of RAM but doesn't sell them to anyone else.

Other American vendors such as Micron and Texas Instruments, as well as Europeans such as Siemens, are lesser players. But IBM, DEC, HP, and other American firms recently united to create a new conglomerate: U.S. Memories Inc., which will compete with the Japanese to produce the new generation of 4-megabit RAM chips.

You can now buy the DRAM (dynamic random access memory) chips used on most motherboards and expansion cards in three different forms. Your choice is restricted by the motherboard or expansion board you buy, because the design of the board determines which form of RAM it needs. Each form has its own advantages for purchase and installation, but once you turn on your computer, it makes no practical difference which form you decide to use.

The most familiar form of RAM are the *dual in-line package* (DIP) chips that look like silicon centipedes. They're the cheapest of all, but they occupy the most real estate on motherboards and expansion boards. If you're not attentive during installation or replacement, you can bend the pins, but you can buy a device to insert or re-



Intel's Above Board Plus 8 I/O uses DIP chips for up to 14MB of memory with the piggyback daughtercard.

move DIP chips and to straighten pins before installation. In the summer of 1989 you could buy a megabyte of 100-nanosecond DIP RAM (9 1Mb chips) for about \$160 from a mail-order supplier. A 33-MHz computer would probably need slightly costlier 80- or 85-ns. RAM instead. The hardware caches used in fast 386 computers normally makes faster RAM unnecessary.

You can still buy 256-, 64-, and 16-kilobit DIPs, but they'll end up costing you more than the corresponding 1-megabit chips. As for the future, IBM announced in June 1989 that it was producing 4Mb DIPs "in quantity" for use in its own computers. Hitachi announced a few days later that it would have similar chips ready for the open market. Initial pricing, expected to drop quickly, may be in the \$1,000-per-megabyte range.



More-expensive and -compact forms of RAM are SIPs (single in-line packages) and SIMMs (single in-line memory modules). SIPs look like moustache combs. They consist of a narrow board with surface-mounted RAM and a row of pins extending from one of the longer edges. SIPs are tricky to install by hand, but are often factory-soldered to the underlying board. This makes replacing a problem chip difficult, so it's better to send these boards back to the factory for modifications. A megabyte of RAM on an 80-ns. SIP (nine 1Mb chips) cost about \$290 in the summer of 1989.

SIMMs look like miniature expansion boards. With the same narrow shape as SIPs, they snap conveniently into a socket on a motherboard or memory board. Almost anyone can install SIMMs without worrying about damage or errors, and removing low-capacity modules is only slightly more troublesome. A megabyte of RAM on an 80-ns. SIMM (nine 1Mb chips) costs about \$230. Expect to pay a bit more for the special SIMMs IBM uses on the motherboard of the PS/2 Models 30 and 50—and about twice as much for the special SIMMs required in the Model 70 and 80.

There's more to RAM than type; speed also plays a role in your buying decision. Remember as you run for the fastest chips in sight that spending extra money for speedier RAM is worthwhile only up to a point. While system memory can whiz along unhampered, slot memory is inhibited by the speed of the bus, and in the case of 286 computers, we're probably talking about 8 MHz or at the most 10 MHz. Anything faster than 100 ns. probably isn't worth the dough, and 120-ns. chips on a LIM EMS 4.0 board could be all you'll need in order to take advantage of the assets of your 286.

on an AT" in *Advisor*, *PC Magazine*, September 12, 1989.)

ABILITIES GALORE

But adding full LIM 4.0 capability to an 80286 means installing an EMS board especially designed to support the 4.0 specification. Older EMS boards will support only 3.2 or, in some cases, EEMS. All the boards in this survey can be used to add LIM 4.0 memory, AT-style extended memory, or both, depending on the configuration you choose when installing them. Computers with 8088 chips normally need their own expanded-memory boards, although some EMS boards designed mainly for 80286 machines, such as those from Intel, can also be used in an 8088.

An EMS board can also fill out to 640K the 512K of DOS memory that comes on many AT motherboards. Depending upon how much backfilling memory capability they have, these boards also allow you to disable some or all of the memory already on your motherboard and instead use EMS RAM for DOS. This technique isn't as wasteful as it sounds if you plan to use *Windows* or *DESQview*. It allows the EMS driver to address DOS memory in the same way it addresses expanded memory, and this "mappable conventional memory" allows *Windows* and *DESQview* to load more applications into memory and to switch more quickly among them. At the moment, only *Windows* and *DESQview* use mappable conventional memory—no applications make use of it—so you don't need to bother with it if you use EMS only to load large spreadsheets into 1-2-3.

With the help of two ingenious and indispensable new utility packages, a LIM 4.0 board in an 80286 or even 8088 machine now gives you some of the advantages normally available only on a 386 machine. Quarterdeck Office System's *QRAM* (price not yet available) and Qualitas's *Mov 'EM* (\$89), both scheduled to appear shortly before this issue hits the streets, will let you move device drivers and memory-resident programs out of DOS memory and shoehorn them into the unused portions of RAM that lie between 640K and 1MB. You can use these programs either to reclaim RAM for DOS applications or to add TSRs that you never had room for before. Both packages include utilities that help you find and use every last byte of memory in the over-640K region that isn't already used by expansion cards and the computer's BIOS.



EXPANDED VERSUS EXTENDED MEMORY: TWO APPROACHES TO MOVING DATA

The task: to move a cell from A1 to location IV16384 in a *Microsoft Excel* spreadsheet that stretches across a full megabyte of memory.

The extended solution:

- (1) find the memory address of the target cell;
- (2) move data directly into target cell.



The expanded solution:

- (1) find page in which target cell is located;
- (2) bank-switch page into EMS addressing window;
- (3) find memory address of target cell;
- (4) move data into target cell.

The task: to move a range of cells from A1:Z26 to location AZ:52 in a *Microsoft Excel* spreadsheet that stretches across a full megabyte of memory.

The extended solution:

- (1) find the memory address of the first target cell of the range;
- (2) use microprocessor string move instruction to relocate data one word at a time.



The expanded solution:

- (1) find page in which target cells are located;
- (2) bank-switch page into EMS addressing window; if range fits into one page, the range move is complete; if not, more pages may need to be switched.

Running *Microsoft Excel* in two different environments results in two different memory types: under OS/2's Presentation Manager the data moves in extended memory, and under *Windows/286* in DOS the data moves in expanded memory.

When moving small random blocks of data, extended memory has an inherent speed advantage, but one that is rarely apparent to the user. Although more steps are involved in moving bytes through expanded memory, the instructions are carried out so rapidly on the microprocessor's time scale that there is no appreciable speed difference.

When moving large blocks of data, however, expanded memory can sometimes pull ahead, because a whole range can be switched into the addressing window with a few instructions. Moving memory blocks in extended memory will require at least as many microprocessor clock cycles as words to be moved (in 16-bit systems a word is 2 bytes).

Speed gains in memory access for add-in boards are tough to come by; both types of memory are inhibited by bus speed, as all slot memory is only as fast as the bus through which it must pass.

MULTITASK ON A 286

The LIM 4.0 specification permits boards to switch from one application using alternate registers to another using alternate registers rather than making most hardware changes to the software. Seven of these registers are used by some multi-terminate register sets of some software. Seven of these registers are used by some multi-terminate register sets of some software. Seven of these registers are used by some multi-terminate register sets of some software.

Without is generally (See the sidebar "That Wasn't a Mission.")

has so far come to extended switching (of the AST and CEI boards) to perform a task that can't be performed by slower boards.

occurs in a multitasking environment when you use communications software in the background to receive data at 9,600 bits per second or faster. A slower board will lose some of the data being received—a faster one won't. In the real world, however, if you seriously intend to receive data at 9,600 bps in the background, you should be doing it on an 80386 machine rather than a 286 with an EMS board installed.

LIM 4.0 FOR NON-ATs

Owners of 286 PCs certainly aren't the only customers for LIM 4.0. In a 386 machine, you should configure all your RAM above 1MB as AT-style extended memory and use a special 386 driver to convert some or all of it to LIM EMS 4.0 memory. DOS 4.0 includes a driver that performs this feat, but two commercial programs, Qualitas's *386-to-the-Max* and Quarterdeck's *QEMM-386*, accomplish far more. These two products are nearly identical. Both programs have virtually the same set of features; if one adds a feature that the other doesn't have, the other will add it a few weeks from now.

If you have a PS/2 Model 50 or 60 with memory expansion from IBM—instead of a third-party memory board that comes with its own EMS driver—you have two

choices. You can buy Quarterdeck's *QEMM-50/60*, a software driver that supports LIM 4.0, or you can switch to IBM's DOS 4.0, which includes a driver that gives you LIM 4.0 memory with IBM's memory-expansion units for PS/2 machines.

If you buy one of these add-in boards for your 80286 machine and later upgrade

to a 386, you haven't lost your investment. Except for a few superfast models, almost all 386 computers let you install 16-bit memory boards. All you have to do is reconfigure the board for AT-style extended memory and tell the computer's SETUP program to add the amount of RAM on the board to the memory already in the machine. Your 80386 EMS driver will automatically convert the board's AT-style extended RAM into LIM expanded memory,

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although the board's 16-bit RAM will be slower than the 32-bit RAM already in the 80386 computer. You can use only one EMS driver in any system, so you shouldn't use the EMS driver that comes with the board itself.

RIGOR CITY

PC Labs took the ten boards in this survey, loaded them with 8MB of RAM, and subjected them to tests of LIM 4.0 compatibility that were evidently more thorough than the tests used by some of the manufacturers. A few boards locked up when we first tried to run the tests. We informed the manufacturers, who supplied working drivers. All of the boards passed our LIM 4.0 compatibility tests.

Don't rule out a board because its list of extra features is short. If you won't be multitasking on your 286, a board without alternate hardware-register sets or much backfill capability will more than suit your needs. As you compare memory boards, keep in mind the configuration of your machine. Some boards have piggybacks that protrude into the next spot, restricting its use. Other boards have bus-speed ranges as narrow as 8 to 10 MHz, whereas Profit Systems' Elite 16 Plus HyperCache zooms from 8 to 20 MHz.

Switchless installation is important to some users, while others see it as a limiting design. RAM price can also influence a buying decision; different manufacturers price their RAM differently, so find out if the manufacturer will sell empty boards and then comparison shop to get the best deal on RAM chips.

Before you buy a LIM 4.0 board, consider filling up your system board with extended memory. You can then either program some of this RAM as expanded memory and forgo true LIM 4.0 capability or leave it as extended memory and add full LIM 4.0 with an add-in board. Many PCs, such as the Northgate 286/12 and CompuAdd 286/12, take only 1MB of conventional/extended memory on the motherboard, but competitors such as Dell, Zenith, and Everex pack 4MB or more on the system board. The Compaq Deskpro 286e has a proprietary slot for its own memory board running at the full system speed of 12 MHz, but if speed isn't a priority, one of the boards in this roundup will happily fill one of Compaq's other 16-bit slots.

It's enough to make you wish the PC's original designers had seen Lotus 1-2-3, Release 3, coming.

AST RESEARCH INC.

RAMpage Plus 286

by Robert W. Kane

How do you make a good product even better? If you are AST, you follow up the Editor's Choice RAMpage ("Leveraging RAM with LIM 4.0," *PC Magazine*, October 11, 1988) with the RAMpage Plus 286. Embracing the latest advances in memory board technology, the \$595 RAMpage Plus is one of the best LIM 4.0-capable boards on the market at the moment.

There is virtually no similarity between the RAMpage of old and the RAMpage Plus. The old board was characterized by DIP switches for setting memory addresses, DIP DRAMs for the memory itself,

an RA-maximum capacity of 2MB. The form-plus 286 uses software to perform this leading installation, SIMM density in it, 8MB per board. All technology comes with a RAMpage Plus 286. The board has its own among conventional memory, and a separate diagnostic board or memory once it has or added to. Instead, AST POST (power-on self test) of machines to check conventional and

ing systems to shift among applications instantly. When the supervisory software transfers control from one task to another—typically on the order of 18 times per second—it only needs to peek at the second set of registers to see where it can reach the needed program code in memory.

The weakness of the LIM EMS 4.0 standard is that it allows a conforming product to have one or more sets of page-mapping registers. Boards with only one set have hardware enough to track only one task. Boards in this roundup have up to 64 alternate hardware register sets, although after a certain point, the benefit of extra registers diminishes. The general rule of thumb is that there should be one register set for every multitasking application. If you want to run four applications, your board should have four registers; a board with 64 won't make your four tasks run any faster. And running 64 programs at once would be so taxing to the microprocessor that it would be counterproductive.

Regardless of the standard's minimum specifications, some programs written for LIM EMS 4.0 absolutely require multiple registers. LIM EMS 4.0 accommodates these programs by add-

EMS 4.0: The Standard That Wasn't

by Winn L. Roesch

If a camel is a horse designed by a committee, LIM EMS 4.0 is a standard crafted by an entire congress. As with any cooperative effort, the Lotus/Intel/Microsoft collaboration incorporates some compromises. Any one of these can catch you unawares and confound your efforts at multitasking.

Put simply, some LIM EMS 4.0 boards don't do multitasking. While many expanded memory boards support concurrent program operation on 8088 and 80286 computers, some do not—even though they follow the LIM EMS 4.0 standard to the letter. This incongruity results from the way that the LIM EMS 4.0 standard specifies page-mapping registers.

Page-mapping registers are special hardware memory areas on an EMS board that record where information is stored in memory. That is, the register indicates which bank of RAM chips stores the bits used by a program or task. When a certain piece of code or data is required, the register points to its physical location in the memory hardware.

While one set of page-mapping registers is necessary if a LIM EMS 4.0 board is to work at all, multiple sets allow the control software of multitask-

PC FACT FILE

RAMpage Plus 286
 AST Research Inc., 2121 Alton Ave., Irvine, CA 92714; (714) 863-1333.
 List Price: With 2K RAM, \$595; with 512K RAM, \$695; with 2MB RAM, \$1,445.
 Requires: IBM PC AT or compatible.
 In Short: AST, which helped shape the LIM EMS 4.0 specification, pushes LIM 4.0 even further with the RAMpage Plus 286. While not the lowest-priced board reviewed, its wealth of features make up for its premium price.

CIRCLE 398 ON READER SERVICE CARD

memory partitions and runs extensive memory tests through its REMM.SYS device driver to check expanded memory for errors.

Some of the most advanced features you could ask for in a LIM 4.0-capable board are found on the RAMpage Plus 286: 32 hardware-mapping register sets,

support for DMA (direct memory access) paging, and 640K conventional memory backfill via EMS push the AST product into an area of functionality that few other memory boards approach. Combined with optional parallel and serial ports, the RAMpage Plus is a one-stop solution to your memory and I/O needs.

The only peculiarity found in the AST board was in its REMM.SYS device driver. The default configuration has support for only 32 handles. The LIM 4.0 specification suggests that an EMM (expanded memory manager) provide a minimum of 64 handles. (Handles are used by an EMM to keep track of segments of expanded memory requested by applications.) The thinking behind reducing the handle count was that most people are using applications written for EMS 3.2 and probably wouldn't need more than 32 handles. Do-

ing this saves conventional memory space and reduces overhead on the EMM driver. The handle count can be changed to any value up to 255 (the maximum number of handles that is allowed under LIM 4.0), via a switch on the device driver command line, in case your applications requesting LIM 4.0 resources don't function properly with the defaults.

All in all, the RAMpage Plus 286 is a seamless product. Pushing the memory specification as it has for some time, AST is a force to be reckoned with when you're considering LIM EMS 4.0 capabilities. It won't be surprising if the next version of the specification is called ALIM 4.1.

COMPUTER ELEKTRONIK INFOSYS OF AMERICA

RAMflex

by Edward Mendelson

ing routines to the driver that simulate multiple registers. Some of these routines are function calls—short program routines that match generic software to the specific LIM EMS 4.0 board hardware.

One such function call handles shifting between registers. With expanded memory boards that have only one set of page-mapping registers, this function call executes a complicated pirouette each time a multitasking system shifts from one task to another. It must copy the values from its registers to reserved RAM, find the next set of register values elsewhere in RAM, and transcribe the alternate values into the registers. This complex process can take so long that it makes true task concurrency untenable.

So why are these stunted EMS boards allowed to fit the LIM EMS 4.0 standard? The answer can be traced to the committee nature of the specification. The companies that promulgated the LIM EMS 4.0 standard all had existing products, some of which were designed for the EEMS (Enhanced Extended Memory Specification) standard (which requires two sets of page-mapping registers) and others that conformed to EMS 3.2 (which requires

only one). By not designating a specific number of registers and by using driver software as a Band-Aid, makers of both kinds of boards almost instantly had products that could be sold under the new LIM EMS 4.0 banner.

There are some advantages to the flexible standard. With the passage of time, designers are likely to improve their products and make them increasingly adept at multitasking. We're not forever stuck with LIM EMS 4.0 boards with just a single set of page-mapping registers—or even merely two. In addition, the LIM EMS 4.0 standard allows DMA (direct memory access) page-mapping registers, so an expanded memory system can quickly shift between normal memory usage and DMA transfers, potentially speeding up such tasks as transfers of disk data to different tasks.

Still, register waffling means you might inadvertently buy a board legitimately labeled as following the LIM EMS 4.0 standard, but which won't support multitasking in your system. If your plans include multitasking, you'll want to be sure that any LIM EMS 4.0 boards you buy support multiple page-mapping registers. All LIM EMS 4.0 boards are not created equal. ■

The \$440 RAMflex memory board, beautifully engineered in Germany by Computer Elektronik Infosys, is an almost-ideal EMS board. It lacks such frills as a RAM-disk, disk cache, and print buffer, but its hardware and EMS driver accomplish their tasks with speed and efficiency. The necessity of setting switches is this board's only drawback, but its excellent installation program takes nearly all of the sting out of this minor inconvenience.

The RAMflex, an XT-height board that fits into any 16-bit slot, is shipped without RAM and has sockets for up to 8MB of 1-megabit DIP DRAM chips rated at 100 nanoseconds or faster. The sleekly finished board makes extensive use of surface-mounted components. The brief manual is technical and detailed but clear enough for less-savvy readers to follow as well.

You start the installation by running a menu-driven program before putting the board into the computer. The program asks you a few questions about your machine but is smart enough to detect the correct answer in most cases and present it on-screen for confirmation. All you have to know is the amount of RAM you've installed on the board. The program then calls up a large graphic display of the switch settings, complete with enough visual cues to make sure you have the switches right side up. The switches themselves are large and easy to set, and all settings are illustrated in the manual.

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RAMflex

Computer Elektronik Infosys of America, 512-A Herndon Pkwy., Herndon, VA 22070; (800) 322-3464, (703) 435-3800

List Price: With 6K RAM, \$440; With 2MB RAM, \$728.

Requires: IBM PC AT or compatible; will fit in XT-height cases.

In Short: This board is sleekly and intelligently engineered, and uses inexpensive 1-megabit DRAMs. It offers no RAMdisk, cache, or print buffer, but you get LIM 4.0 and EEMS drivers for DOS and for OS/2's DOS compatibility box.

CIRCLE 400 ON READER SERVICE CARD

Finally, the installation program asks whether you want to install a LIM EMS 4.0 driver designed for DOS, for the OS/2 compatibility box, or for both. With either DOS or OS/2, if you insist on using the few special functions in the EEMS specification that aren't included in LIM EMS

4.0, you can choose an EEMS driver instead of a LIM EMS 4.0 driver. When you've made your selection, the program installs the software on your hard disk and modifies CONFIG.SYS. Plug the board into the computer, run SETUP if necessary, and you're ready to enter the world of massive memory.

The RAMflex board is one of the few boards on the market that can backfill all 640K of DOS, so you don't need to use any memory on your motherboard at all. And if your equipment includes a monochrome monitor, your total can climb to 704K of DOS RAM.

In the PC Labs EMS compatibility and performance tests, the RAMflex board performed without any errors and at extremely impressive speeds. The board boasts a noteworthy 64 alternate register sets, boosting the board to top-ranked times on several performance tests. As for

bus speeds, the RAMflex is comfortable running at up to 12.5 MHz.

The designers of Computer Elektronik Infosys's RAMflex board assume that you're resourceful enough to find a RAMdisk, print buffer, and disk cache on your own. What the RAMflex offers is low-priced, superbly engineered hardware with a fast and flawless LIM driver. If you're willing to set a few switches, it's hard to imagine how you could ask for more from an EMS board.

COMPUTER PERIPHERALS INC.

CPI XMA-II

by Joseph J. Antinori

Computer Peripherals' latest addition to the XMA product line, the CPI XMA-II, has a whopper of a price and a higher RAM capacity than its predecessors. At

THE BEST RAMDISKS IN LIFE ARE (ALMOST) FREE

by Edward Mendelson

Most EMS boards come with software that installs a print spooler, disk cache, and RAMdisk into expanded memory. But some boards are missing such software, and others include low-grade stuff that you'd rather replace than use. Agonize not; better-designed alternatives abound.

The fastest and finest EMS print spoolers are *TORQ*, designed for dot matrix and daisy wheel printers, and *LaserTORQ*, for laser printers, both offered by LaserTools Corp. for less than \$100 each. The best disk cache is a *PC Magazine* Editor's Choice winner: Multisoft's \$79.95 *Super PC-Kwik*.

But once you start looking for an EMS RAMdisk you don't need to shell out any more cash. There are several such programs to be had for nothing or next to nothing. Memory management software can configure expanded memory in such a way that DOS recognizes it as a disk drive, creating an EMS RAMdisk. Version 4.0 of IBM DOS gives you an EMS RAMdisk in the form of VDISK.SYS, and Versions 3.2 and later of MS-DOS provide an EMS RAMdisk in RAMDRIVE.SYS. If you use pre-4.0 versions of IBM DOS, your copy of VDISK works in DOS memory

or extended memory only, and you need to look elsewhere to find an EMS RAMdisk.

The two best are available on PC MagNet and many BBSs. *PC Magazine*'s own XPANDISK, by Michael J. Mefford, lets you increase or decrease the size of the RAMdisk without rebooting your computer. The contents of the disk are erased when you alter the size, but it's still a lot more convenient than rewriting your CONFIG.SYS file and rebooting whenever you need a larger RAMdisk. Look for XPANDISK .ARC on MagNet—it's free.

For the RAMdisk that sacrifices the smallest amount of DOS memory, get NJRAMDSK—short for Nifty James' Famous Expanded Memory RAM Disk Drive. (Nifty James is the pen name—or keyboard name—of Mike Blaszczyk.) All RAMdisks are fast, but his is probably the fastest of all. It occupies a mere 720 bytes or less of DOS memory and comes with a special version that works at even higher speeds in 80286 and 80386 machines.

All physical disk drives make a slight noise when you access them, but RAMdisks are totally silent—that is, except for NJRAMDSK, which makes

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NJRAMDSK

Mike Blaszczyk, 112 Verinden Dr., Monroeville, PA 15146-2041.

List Price: Shareware available on BBS or on-line services; \$15 contribution. Requires: DOS 2.0 or later.

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LaserTORQ

TORQ

LaserTools Corp., 5900 Hollis St., Suite G, Emeryville, CA 94608; (800) 346-1353, (415) 420-8777.

List Price: TORQ, \$79; LaserTORQ, \$99

CIRCLE 397 ON READER SERVICE CARD

Super PC-Kwik

Multisoft Corp., 15100 SW Koll Pkwy., Suite L, Beaverton, OR 97006; (800) 268-5945, (503) 644-5644.

List Price: \$79.95.

CIRCLE 396 ON READER SERVICE CARD

a clicking noise to signal when you access it. Fortunately you can turn the click off. NJRAMDSK is shareware, with a registration fee of \$15. Look for NJRAMD.ARC on MagNet or NJRAMDSK.ARC on any BBS. Why pay more? ■

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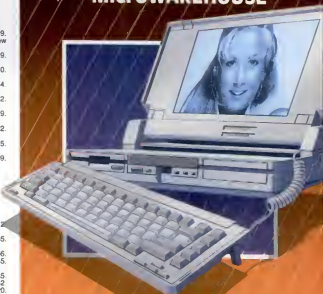
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PlanPerfect 5.0	239.
WordPerfect 5.1	New

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Teac	
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Wealthbuilder (Realty Tech.)

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Series 9 w/Plot. Show (b/s/PS2)	92-78.
Microsoft (New)	
Mouse w/Pan/brush (bus/ser)	99.
Mouse w/Windows & Paint(bus/ser)	131.
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MODEMS & FAX BOARDS

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Quadram	
JT Fax Board 4800bd Int	215.
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Supra Modem 2400	New
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Math CAD 2.5	285.

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Nylon 554. Leather \$139.





FACT FILE

CPI XMA-II

Computer Peripherals Inc., 667 Rancho Conejo Blvd., Newbury Park, CA 91320; (805) 499-5751, (800) 854-7600.
List Price: With 2MB RAM, \$1,795; with 8MB RAM, \$2,995.

Requires: IBM PC AT or compatible.

In Short: A full-featured board that is not as sleekly designed as one would expect for its hefty price tag. It boasts 16 alternate mapping register sets but is hampered by a complicated installation procedure.

CIRCLE 401 ON READER SERVICE CARD

\$1,795 with 2MB RAM, the XMA-II was designed in conjunction with Quarterdeck Office Systems to excel at running under multitasking environments such as *DESQview* or *Microsoft Windows*. While the board's 16 alternate mapping register sets make it ideal for such applications, it suffers from a few engineering clunkers.

The XMA-II is studded with ten jumper switches and seven dip switches to be set during installation. A utility that diagnoses your DIP switch settings is included, or if you know the starting address of your extended memory, you can look up the settings in the table provided. Full-page diagrams of the proper jumper settings are also available.

The 43-page manual is exhaustive in its detail of the multitude of functions and capabilities of the XMA-II board, and it's clear and easy to read. Every step of the comparatively intricate installation process is fully explained, and excellent diagrams and tables help you along the way. Still, the XMA-II's plethora of switches just doesn't seem right at this high level of the technology food chain.

Our testing called for dividing the 8MB of available memory equally between expanded and extended modes; the XMA-II was unique in its inability to perform this task—it was able to provide only all extended memory or expanded with backfill 384K. The XMA-II's failure to access both forms of memory simultaneously limits its flexibility.

This card will run safely at bus speeds of up to 12 MHz. Its LIM 4.0 driver conformed exactly to the specification, and there were no problems with its extended mode.

The XMA-II comes with a print spooler, a RAMdisk, and a disk caching program for EMS memory, all of which are installed by adding the appropriate entry to

your CONFIG.SYS file. The board also sports a parallel port.

The layout of the Computer Peripherals board is quirky. The XMA-II is composed of two printed circuit boards: one board is populated only by logic chips, and a "memory subassembly" contains all of the 100-nanosecond 1MB DIP chips. The two boards are joined by a 52-pin connector. Despite this necessary piggyback assembly, the board still takes up but one slot.

The Computer Peripherals XMA-II has all of the features you expect from a memory card in this category—including a five-year warranty—plus 16 alternate mapping register sets to boost its multitasking abilities, but it's not for the faint of heart. Its relatively high price and user-intensive installation process weigh heavily against its finer qualities.

EVEREX SYSTEMS INC.

Everex RAM 8000 AT

by Edward Mendelson

Everex Systems' \$499 Everex RAM 8000 AT is a no-frills EMS board, designed for the user who isn't frightened by the intricacies of editing a CONFIG.SYS file.

Everex won't sell you any RAM with the board, but you can install 2-, 4-, 6-, or 8MB worth of 1-megabit DRAMs rated at speeds of 120 nanoseconds or better. Eight megabytes should be more than enough for any sensible 80286 system, but if it leaves you hungry for more, you can install up to four of the Everex boards in one machine.

Everex leaves most of the installation to you. The menu-driven program that sets the board's hardware configuration will allow you to backfill DOS memory from 256K or 512K up to 640K and then add some extended memory. RAM can be allocated in blocks as small as 128K, and when you're through, the program stores your chosen configuration in an EEPROM (electrically erasable programmable ROM). All you have to do afterwards is run your computer's SETUP program to report the added memory. You'll only need to set a switch on the board's small switch block if you want to limit the active memory on your motherboard to 256K or if you want to install more than one RAM 8000 AT board in your PC.



FACT FILE

Everex RAM 8000 AT

Everex Systems Inc., 48431 Mimont Dr., Fremont, CA 94538; (800) 821-0806, (415) 498-1111.
List Price: With 8K RAM, \$499; with 2MB RAM, \$559.

Requires: IBM PC AT or compatible.

In Short: Everex's low-cost, simply designed board uses inexpensive 1-megabit DRAMs for up to 8MB of memory. Software installation is essentially manual, and hardware installation is switchless in most circumstances.

CIRCLE 402 ON READER SERVICE CARD

But you will probably buy the board for the sake of its LIM expanded memory, and to use it you'll have to modify CONFIG.SYS by hand, since Everex does not provide a utility that does this for you. The line you have to add in order to install the LIM expanded memory manager includes a long series of optional parameters, most of which you can cheerfully ignore.

The RAM 8000 AT comes with a print spooler, RAMdisk, and disk caching program. All can be loaded into DOS memory, LIM memory, or extended memory. Like the LIM EMS driver itself, you have to install them by writing new lines in CONFIG.SYS.

In PC Labs benchmark tests, the Everex board was an average performer, settling in at the middle of the pack in most tests. Everex's bus speed range is narrower than most; 8 to 10 MHz rather than 6 to 12. The board contains three alternate register sets in hardware for reasonably fast task-switching in EEMS and LIM EMS 4.0 operations. Its LIM 4.0 driver had no problem conforming to the published specification.

The Everex RAM 8000 AT is a solid, no-nonsense board whose reasonable price merits serious consideration by the budget-minded.

INTEL CORP.

Above Board Plus 8 I/O

by Edward Mendelson

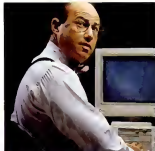
Intel Corp.'s Above Board Plus 8 I/O has a name as complicated as a European aristocrat's list of titles. The Above means it supports memory above DOS's limit. The



"Uh, my system crashed and my file disappeared."



"I'm sorry about those files but I'm sure there's hard copy around here somewhere."



"Someone must have been playing with my computer while I was out to lunch."



"My secretary spilled a cup of coffee on my desk and it ran over my disk."



"I don't know what happened to the files, they just disappeared."



"Nobody told me that I was supposed to backup."



"My dog ate my data."



"I put the files on the floppy and then someone must have taken my disk."



"Well, it's a long story and I wouldn't want to bore you..."



"Have you ever had one of those days?"



"I can't believe that it's my fault, it's your system."



"I think I'm in trouble here."

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ADD-IN MEMORY BOARDS

LIM EMS 4.0



LIM EMS 4.0: SUMMARY OF FEATURES

(Products listed in ascending price order)

	 STB RapidMEG STB Systems	JustRAM/ATZ Monolithic Systems	RAMflex Computer Elektronik Insoys of America	JustRAM/AT16 Monolithic Systems
List Price with no RAM	\$399	\$425	\$440	\$445
MEMORY CAPACITY				
Minimum RAM	512K	2MB	2MB	512K
Maximum RAM without piggyback	8MB	4MB	8MB	16MB
Maximum RAM with piggyback	N/A	8MB	N/A	N/A
Amount of conventional memory backfill	Up to 364K	128K	Up to 640K	128K
Number of alternate mapping register sets	Limited by system memory	None	64	None
Alternate register sets implemented in hardware or in software	Software	N/A	Hardware	N/A
Supports DMA paging	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Supports page mapping below 640K	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Supports extended memory	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Can divide memory into extended and expanded partitions for simultaneous use	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> (with daughtercard)	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Minimum expanded memory partition	16K	128 K	128K	126K
Minimum extended memory partition	16K	128 K	128K	126K
COMPATIBILITY				
Supports LIM EMS 4.0 in software or in hardware	Both	Software	Hardware	Software
Simulates EMS versions earlier than 3.2	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Supports EMS under OS/2's DOS compatibility box	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
TSR programs can be loaded into EMS memory	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
HARDWARE CONFIGURATION				
Number of slots used by board (without piggyback)	1	1	1	1
Number of slots used by board (with piggyback)	N/A	1	N/A	N/A
Standard ports	None	None	None	None
Optional ports	None	None	None	None
AT bus speed compatibility range	6-12 MHz	8-12 MHz	8-12.5 MHz	8-10 MHz
RAM packaging (type and capacity)	256K or 1Mb SIMMs	1Mb DIPs	1Mb DIPs	256K or 1Mb SIPs
Speed of RAM if supplied by board manufacturer (nanoseconds)	100	100	100	100
Range of supported RAM chip speeds	80-120	100 or faster	100 or faster	100 or faster
Wait states	0	0	0	0
SOFTWARE INCLUDED				
Installation	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Diagnostics	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Print spooler	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
RAMdisk	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Disk cache	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Expanded memory manager	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Other	Memory status utility	None	None	None
SETUP AND WARRANTY				
Additional memory is user-installable	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Has switchless installation	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Length of warranty period	2 years	1 year	2 years	1 year

—Editor's Choice ☒—Yes ☐—No N/A—Not applicable; product does not have this feature.

Everex RAM 8000 AT Everex Systems	RAMpage Plus 286 AST Research	Elite 16 Plus HyperCache Profit Systems	Concentration Newer Technology	Above Board Plus II I/O Intel Corp.	CPI XMA-II Computer Peripherals
\$499	\$595	\$795	\$1,095 (with 2MB RAM)	\$1,445 (with 2MB RAM) \$1,495 with I/O	\$1,795 (with 2MB RAM)
OK	512K	512K	2MB	2MB	2MB
8MB	8MB	16MB	32MB	8MB	OK
N/A	N/A	N/A	N/A	14MB	8MB
Up to 384K	Up to 640K	Up to 512K	Up to 640K	Up to 384K	Up to 384K
128	32	1	4	None	15
Hardware	Both	Hardware	Both	N/A	Both
■	■	□	□	□	■
■	■	■	■	■	■
■	■	■ (with AutoROM option)	■	■	■
■	■	■	■	■	□
128K	128K	16K	16K	128K	16K
128K	128K	16K	128K	128K	16K
Both	Both	Both	Both	Both	Both
□	■	□	■	□	■
■	■	□	□	□	■
■	■	■	■	■	■
1	1	1 1/2	1	1	1
N/A	N/A	N/A	N/A	1 1/2	1
None	None	One serial, one parallel	None	One serial, one parallel, I/O	One parallel
None	One serial, one parallel	Second serial	None	None	None
8-10 MHz	6-10 MHz	8-20 MHz	5-14 MHz	6-12.5 MHz	4-12 MHz
1Mb DIPs	256K or 1Mb SIMMs	256K or 1Mb SIPs	256K or 1Mb SIMMs or SIPs	1Mb DIPs	1Mb DIPs
120	100	120	80	100	100
120 or faster	100 or faster	120 or faster	60-150	120 or faster	80-120
0	0, 1	0, 1	0, 1, 2	0	0, 1, 2
■	■	■	■	■	■
■	■	■	■	■	■
■	■	□	■	■	■
■	■	□	■	■	■
■	□	□	□	□	■
■	■	■	■	■	■
None	None	None	None	None	EMS simulation
■	■	■	■	■	■
■	■	■	■	■	□
1 year	2 years	5 years	1 year	5 years	5 years

A black and white photograph of Chuck Daly, a man with short dark hair, wearing a dark suit, white shirt, and dark tie. He is holding a basketball with both hands in front of him.

*Chuck Daly
Head Coach
NBA Champions
Detroit Pistons*

“In This League,
The True Superstar
Not Only Gives You
An Outstanding Individual
Performance, But
Also Elevates The Play
Of The Team.
Because Teamwork
Is Everything.”

A black and white photograph of Bill Thompson, a man with dark hair and a mustache, wearing a dark suit, white shirt, and a red tie. He is gesturing with both hands open, palms up.

*Bill Thompson
Director of MIS
The Sherwin-Williams Company
Paint Stores Group*

Introducing The NCR PC486/MC.



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PERFORMANCE TESTS: LIM EMS 4.0

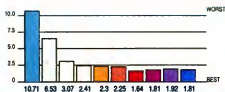
An AT-class LIM EMS 4.0 memory board needs more than alternate hardware register sets to turn in fancy performance times. One of the top performers, the STB RapidMEG, lacks hardware registers but zips along with the help of a sophisticated EMS driver.

The LIM EMS 4.0 Move Tests measure the time it takes an EMS system (board and driver software) to move a 256K block of data using EMS function 24. The tests are performed twice, once with 64-byte records and once with 128K records. Total time is reported in seconds.

64-BYTE-RECORD MOVE TESTS

Expanded to conventional

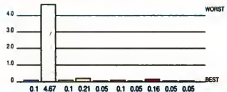
Elapsed Time (seconds)



128K-RECORD MOVE TESTS

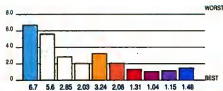
Expanded to conventional

Elapsed Time (seconds)



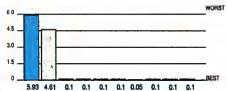
Conventional to conventional

Elapsed Time (seconds)



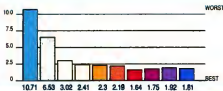
Conventional to conventional

Elapsed Time (seconds)



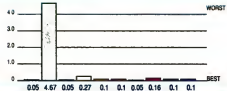
Conventional to expanded

Elapsed Time (seconds)



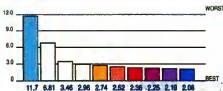
Conventional to expanded

Elapsed Time (seconds)



Expanded to expanded

Elapsed Time (seconds)



Expanded to expanded

Elapsed Time (seconds)



10.71 Plus HyperCache
Above Board Plus 810
JusRAM/NT16
Raidage Plus 286
Eurus RAM 8000 AT
JusRAM/NT2
Raidage
Conqueror
CPI RAM-4
STB RapidMEG

0.05 Plus HyperCache
Above Board Plus 810
JusRAM/NT16
Raidage Plus 286
Eurus RAM 8000 AT
JusRAM/NT2
Raidage
Conqueror
CPI RAM-4
STB RapidMEG

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PC MAGAZINE, SEPTEMBER 12, 1989

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PC MAGAZINE, SEPTEMBER 12, 1989:

"Context-sensitive help and three levels of automatic prompting offer enough assistance that you may never open the fine manual that accompanies the program."

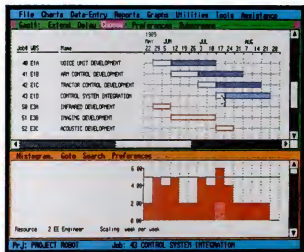
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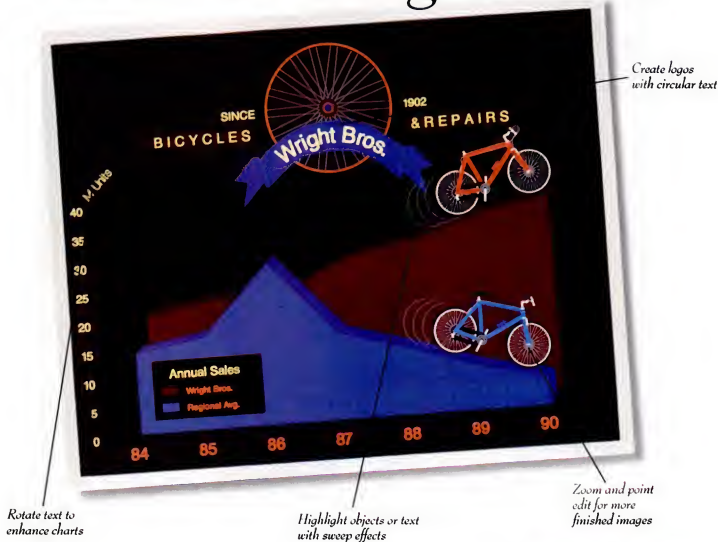
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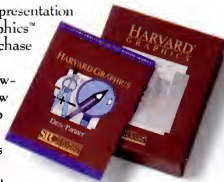


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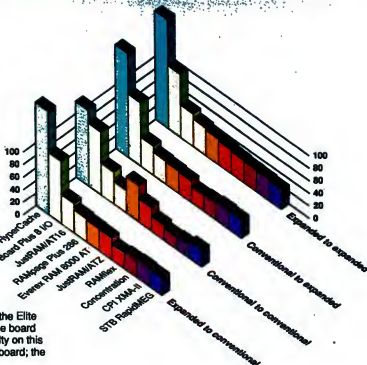


LIM EMS 4.0 PERFORMANCE TESTS: COMPOSITE VIEW

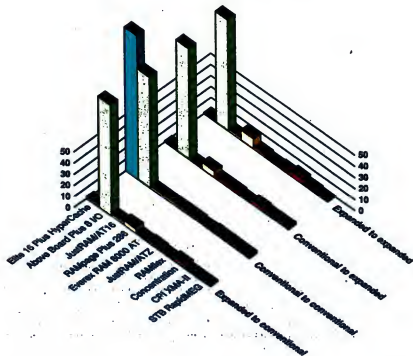
All of the memory boards in this roundup of ten AT-class LIM EMS 4.0 memory boards outperformed Intel's industry standard Above Board Plus 8 I/O in at least three of the PC Labs performance tests. Taking top prizes were CEI's RAMflex, the STB RapidMEG, and Newer Technology's Concentration. The RapidMEG's greatest asset is its efficient EMS driver, as demonstrated by its performance in the expanded-to-expanded move tests. The RapidMEG uses 16-bit expanded memory moves and emulates alternate register sets through software. Thus, even without alternate hardware register sets, the RapidMEG manages speeds on a level with other LIM EMS 4.0 boards. CEI's RAMflex, which has a total of 64 hardware registers for task switching, proved slightly faster overall than the RapidMEG. In terms of EMS software, driver efficiency turns out to be just as important as hardware registers.

While the majority of the boards tested well on the 128K-record EMS move tests, the notable exception was Profit Systems' Elite 16 Plus HyperCache. This board, which provides conventional memory backfill through its EMS device driver, was slower on the 128K-record conventional-to-conventional move test than the Intel board. The Elite 16 also lagged in the 64-byte-record move test (again, slower than the Intel), indicating a tremendous amount of driver overhead for this board. Although the Elite 16's speedy times in the other 128K-record tests indicate that the board itself is very fast, the tested driver imposes a performance penalty on this EMS system. Profit Systems is working on a new driver for this board; the new driver was unavailable for testing at the time of this review.

64-BYTE-RECORD MOVE TESTS



128K-RECORD MOVE TESTS



The PC Labs performance tests for memory boards were performed on an 8-MHz IBM PC AT Model 339 with 512K RAM, EGA display, and a 30MB hard disk. Each memory board was configured to provide 128K of EMS backfill memory to bring the total system conventional memory to 640K. Of the boards' 8MB of RAM, 4MB was designated as extended memory and the remainder as expanded memory. (Since the CPI XMA-II can't be configured for simultaneous use of expanded and extended modes, it was configured for all expanded or all extended memory as required by each individual test.) All other setup options were installed using each board's default modes, including the device drivers for the expanded memory managers.

(Above Board Plus 8 I/O = 100)

ADD-IN MEMORY BOARDS

LIM EMS 4.0

Plus means it has LIM EMS 4.0 capabilities not found in Intel's earlier boards. The 8 means you can stuff up to 8MB of 120-nanosecond (or faster) 1-megabit DRAMs into its sockets. And the I/O means it comes with serial and parallel ports. The board also has an aristocratic list price—\$1,245 with 2MB RAM—although the street price tends to be a lot more democratic. And if you don't want the I/O ports you can pay \$50 less for a stripped-down model.

For another \$1,445 you can buy an optional daughtercard that comes with 2MB of RAM and can hold up to 6MB. The daughtercard adds enough bulk to make the combination occupy one and a half slots, while the board without the daughtercard needs only one.

Intel packs its sockets and circuits on an XT-height board that can even live in an 8-bit PC. To make the board compatible with the 8-bit bus you simply insert a small plug into a socket. Otherwise you won't have to bother with that socket and you also won't have to set jumpers or DIP switches, because the board doesn't have any.

Intel's workmanship and installation are, as usual, superb. If you have a 6- or 8-MHz machine and you want to use the board for LIM EMS memory only, the hardware installation is completely automatic. All you have to do is read a few screens on the installation program and press Enter. To use extended memory in addition to LIM EMS memory or to modify the defaults, you just walk a few simple steps down a lucid series of menus. Unlike earlier Intel boards, this new model lets you allocate your RAM in blocks as small as 128K.

Software installation is equally effortless. A menu-driven program sets up the

LIM EMS manager (with an option to map conventional memory to expanded memory), copies an optional RAMdisk and a print buffer to your hard disk, and modifies CONFIG.SYS. You can save 16K of DOS RAM by installing part of the LIM manager itself in expanded memory. The print buffer has a clever pop-up menu with options to print the screen, suspend printing, or send a form feed, and the menu is clever enough to pop up over any standard graphics screen—although you can't use the PrtSc function to print the graphics screen itself. If you want a disk cache, you must buy your own.

In the PC Labs performance tests that move blocks of memory, the board performed without errors, but its times were

Intel packs its sockets
and circuits on an XT-
height board that can
live in an 8-bit PC.

slow. Intel doesn't support alternate register sets in hardware, so it has to simulate them in software, and the design of its software exacts a considerable speed penalty.

Intel argues that its design lowers the cost of the board and inflicts no noticeable performance penalty in real-world operations using AT-class machines. But there will be a slight speed lag if you multitask using *DESQview* or *Windows*; the delay will diminish if you use these environments to switch between one application and another rather than running different applications concurrently. Intel's board is compatible with buses running at 6 to 12.5 MHz.

This handicap is slight in light of the error-free operation and effort-free installation of the board, as well as the high speed of its reads and writes. Intel gives you a five-year warranty, a toll-free number for tech support, and a BBS from which you can download any new versions of the software. All this, combined with the board's fine workmanship, makes it a highly attractive product. Just don't try to force it into the IBM PS/2 Model 50 illustrated on the cover of the manual—the

Model 50 is an MCA machine with no slots to match the AT-bus connector on the Above Board Plus 8 I/O.

MONOLITHIC SYSTEMS CORP.

JustRAM/ATZ JustRAM/AT16

by Edward Mendelson

Monolithic Systems' affordable JustRAM/ATZ and JustRAM/AT16 boards have differing RAM capacities and similar limitations. Neither board has an option to add serial or parallel ports, nor do they have alternate register sets in hardware. Both boards put you through complicated installation procedures, but you end up with well-designed software that has some special capabilities such as an option to retain the contents of the RAMdisk during a warm boot—a bonus that may endure these boards to programmers whose work frequently crashes during development.

The ATZ model costs \$425 without RAM, and has sockets for 2- to 4MB of 100-nanosecond or faster 1-megabit DRAM chips, as well as sockets for an extra 2- or 4MB on a slim daughtercard that doesn't intrude on the adjacent slot. The \$445 AT16 accepts 256K by 9 or 1Mb by 9 SIPs (single in-line package) at speeds of 100 ns. or better, and holds from 512K to 16MB of RAM in a single slot.

If you decide to install RAM on your own, be prepared for some anxious moments when you press SIP chips into the AT16. SIPs have tiny pins that bend easily, and you have to fit them into a row of tiny sockets.

PC FACT FILE



Monolithic Systems Corp., 7050 S. Tucson Way,
Englewood, CO 80112; (800) 525-7661, (303)
790-7400.
JustRAM/AT16
List Price: With OK RAM, \$445.

CIRCLE 406 ON READER SERVICE CARD

JustRAM/ATZ
List Price: With OK RAM, \$425.
Requires: IBM PC AT or compatible.
In Short: Complex switch settings and jumpers
and a lack of alternate register sets are the
weaknesses of these boards. The highly capable
and flexible software is their main strength. The
ATZ model holds up to 8MB of DIP chips, the
AT16, up to 16MB of SIPs.

CIRCLE 404 ON READER SERVICE CARD



FACT FILE

Above Board Plus 8 I/O

Intel Corp., PCEO (Personal Computer
Enhancement Operator), 5200 NE Elam Young
Pkwy., Hillsboro OR 97124; (800) 538-3373,
(503) 629-7534.
List Price: With 2MB RAM, \$1,245; without serial
and parallel port, \$1,195; 6MB piggyback with
2MB RAM, \$1,445.
Requires: IBM PC, XT, AT, or compatible.
In Short: Intel's board has superior
workmanship, switchless installation, and a
14MB capacity with the optional daughtercard.
The lack of alternate register sets in hardware
slows multitasking in EMS. This is the only 16-bit
EMS card that also works in 8-bit computers.

CIRCLE 403 ON READER SERVICE CARD



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CIRCLE 294 ON READER SERVICE CARD

If you buy a board with RAM already plugged in, installation still requires patience and calm. You have to determine the position of a few pairs of jumpers (including one that tells the board whether you want to backfill DOS memory from 512K to 640K), and then set three banks of switches that are confusingly numbered from right to left. The board lets you allocate memory in blocks of 128K, and the manual lists eight pages of possible switch settings for different starting and ending addresses. The documentation's explanations of how to choose the right addresses and settings are frustratingly sparse, and Monolithic Systems' technical support proved less than expert at answering my questions.

Software installation, despite a moderately confusing interface, is more straightforward. A menu-driven program installs the LIM EMS 4.0 driver, up to eight RAMdisks, a print buffer, and a disk cache. The EMS driver doesn't support

board and 4MB on a "mezzanine" board—all without crowding into the next slot. This board sells for \$725 with 1MB RAM and sports a five-year limited warranty on parts and labor.

The EMS capabilities of Monolithic Systems' JustRAM boards aren't as impressive as the strengths of the software supplied with them—software that can compensate for the rigors of the initial installation. And the prices of both boards are reasonable enough to compensate for some slow going at start-up, so give this pair a try.

NEWER TECHNOLOGY

Concentration

by Robert W. Kane

As the all-out capacity king in this roundup, Newer Technology's Concentration LIM EMS 4.0 board merits special men-

tion. Supporting up to 32MB in one slot, the \$1,095 Concentration comes with 2MB RAM and can pack twice as much memory into the same space as any of its competitors. When combined with the EMS mapper module, included in the \$1,095 price, the Concentration board is one of the most powerful, comprehensive EMS systems available today.

Most users will undoubtedly not purchase the Concentration in its 32MB incarnation. In order to cram that much memory into one slot, the SIMM sockets must be removed and 32 SIP modules must be soldered directly to the motherboard. This configuration is available only from the factory. The 2 megabytes of RAM included in the list price are 85-nanosecond SIMM memory, expandable to 16MB by the user via additional SIMMs.

Putting this monster memory card to work is relatively straightforward and painless. The installation software allows you to set values for conventional memory backfill and extended memory quickly. The software then asks whether the conventional memory backfill should be done

The JustRAM boards simulate alternate mapping register sets in software.

swappable memory below 640K. The RAMdisk, buffer, and cache can all be located in DOS, expanded, or extended memory. The buffer comes with a pop-up menu that stores customized strings of control codes to send to your printer at the press of a key. The cache has an option allowing for cache writes in addition to the default setting that permits only cache reads.

The JustRAM boards don't support alternate register sets, so they simulate them in software, and the results in the context-switching test are rather average. Otherwise, the software passed the LIM EMS 4.0 compatibility test without any difficulty. Both boards run at 8- or 10-MHz bus speeds only.

If you thought two options from one company was a lot, Monolithic Systems offers a third, released too late to appear in this roundup. The JustRAM/ATW is designed for ATs with 6- or 8-MHz bus speeds and holds up to 4MB on the base-

736K DOS FOR THE PRICE OF A PHONE CALL

by Edward Mendelson

By now you're undoubtedly feeling cramped by 640K of DOS. You can get some elbow room from the combination of an EMS board that supports either LIM 4.0 or EEMS and a free program called EEMRAM that you can find on PC MagNet, CompuServe, and most BBSes.

EEMRAM, written by Christopher J. Dunford, is a non-memory-resident program that can increase the DOS memory in many systems to 704 or 736K. Not all applications will use DOS memory beyond 640K, but you don't lose anything by running EEMRAM for the programs that do.

EEMRAM works by mapping the EMS memory on your memory board to DOS addresses starting at 640K and continuing to the point where the memory begins on your video adapter. With a monochrome card you can add 64K, and with a CGA you can add 96K. All you have to do is put EEMRAM in your AUTOEXEC.BAT.

EGA and VGA cards use EEMRAM's memory addresses for their high-resolution modes, but that

shouldn't stop you. You can turn off EEMRAM before running any program that uses high-resolution graphics and then turn it on again when you return to character-based applications.

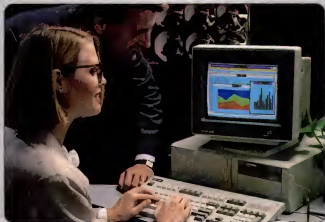
In order to use EEMRAM, your EMS board must be able to map EMS memory to the memory segment at address A000 (640K). Most EMS boards can do this, although some don't document this capability because of the potential conflict with EGA and VGA cards. Intel's boards are a notable exception; Intel prefers total hardware compatibility over the freedom to experiment that lets you use EEMRAM.

Even if EEMRAM won't work in your system, you can't do any harm by trying it. If your system isn't compatible, it offers an error message and ignores the presence of the erroneous program.

To use EEMRAM, download EEMRAM.ARC from PC MagNet or CompuServe. The ARC file contains complete instructions and programs that test your system for compatibility. What have you got to lose? ■

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ADD-IN MEMORY BOARDS

LIM EMS 4.0

PC FACT FILE

Concentration

Newer Technology, 1117 S. Rock Rd., #4, Wichita, KS 67207, (316) 685-4904, (800) 576-3726

List Price: With 2MB RAM, \$1,095.

Requires: IBM PC AT or compatible.

In Short: Capable of holding 32MB in one slot, the Concentration board doubles the capacity of its nearest competitor. While priced on the high side, its ability to work in fast 286 machines makes it an excellent choice for demanding memory applications.

CIRCLE 408 ON READER SERVICE CARD

via the EMS system. This is important for multitasking environments such as *Windows* or *DESQview*, which take advantage of EMS backfill memory as well as alternate hardware registers. The Concentration board can provide conventional memory backfill up to 640K and has a total of four hardware registers for task switching—all the better to exploit the board's 32MB capacity.

The installation disk provides diagnostic routines to pinpoint any bad memory on the Concentration board. Unfortunately,

the manual doesn't mention how to use these routines. When attempting to run the diagnostics, the program called for a DMA (direct memory access) pattern from the disk but could not find one, so it terminated. With such a large memory capacity, it would be convenient to allow the user to perform diagnostics and pinpoint bad memory modules, for repair in the field.

Once you have the board installed and set up, all that remains is to load the EMS driver and start computing. The Concentration's driver conforms to the LIM 4.0 specification and performed flawlessly in the PC Labs tests. With a bus-speed range from 6 to 14 MHz and support for zero-wait-state operation, the Concentration is well suited for both yesterday's plodding AT and today's 286 workhorse.

Although priced a little on the high side (even when you factor in the 2MB of standard RAM), Newer Technology's Concentration is still a board worthy of consideration. If your machine cries out for multiple megabytes of memory in a small amount of space, the Concentration would make a wise investment.

PROFIT SYSTEMS

Elite 16 Plus HyperCache

by Edward Mendelson

Profit Systems' Elite 16 Plus HyperCache is an original. What this \$795 (0K RAM) card shares with other recent EMS boards is its support of the LIM 4.0 specification in hardware, though with only one alternate register set. Almost everything else about the board is unusual, starting with its elaborate name and ending with its unique ability to add extended memory to your system without making you run your computer's SETUP program.

A singular feature of the board is its 16K static RAM hardware cache. The cache works differently depending on the design of the 286 PC in which the board is installed. Computers with IBM's specification insert wait states when the PC accesses memory on expansion boards. If the computer follows the IBM spec, the cache simply allows zero-wait-state access to memory on the board in the same way that

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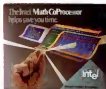
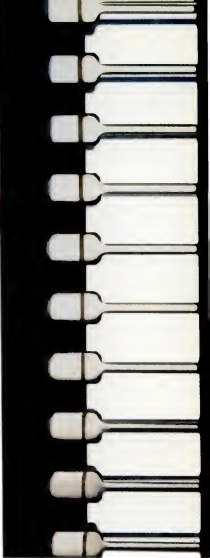
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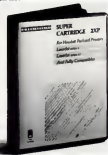
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**Elite 16 Plus HyperCache**

Profit Systems Inc., 30150 Telegraph Rd.,
Birmingham, MI 48010; (313) 647-5010.

List Price: With 0K RAM, \$795.

Requires: IBM PC AT or compatible, one and one-half free slots.

In Short: This board comes only partly assembled, and makes a unique end-run around your computer's SETUP program, but suffers from no obvious incompatibilities. The hardware cache may help in nonstandard systems, although it performed at the low end of the scale on the IBM PC AT.

CIRCLE 406 ON READER SERVICE CARD

other boards allow zero-wait-state access without a cache. But if the computer doesn't follow IBM's example, then the cache actually removes a wait state. This scheme frees the board to operate at bus speeds of up to a whopping 20 MHz.

Most EMS boards operate without adding wait states, and most computers follow IBM's specification, so with most setups Profit Systems doesn't claim that the cache will add any performance benefits. On nonstandard systems, however, the company says the cache should give better performance than you might get otherwise. In PC Labs tests, using an 8-MHz IBM AT, the cache didn't seem to help much. The board turned in performances that were no faster than most of the other boards in the majority of tests—in fact, some results were exceptionally slow.

The cache comes in the form of a small circuit board with 64 pins extending from one edge. You attach it to the larger board by pressing the pins into a matching row of minute sockets. The combination of board and module occupies one and a half slots, and if you can put the two together without bending any pins, you have the right to feel very pleased with yourself.

Similar pins and sockets await you if you decide to add RAM to the board. There are sockets for up to 16 SIP chips, and you can use 256K by 9 or 1Mb by 9 SIPs to populate the board with anything from 512K (the amount with which it is shipped) to 16MB. The board comes with a parallel port and serial port that can be used only as LPT1 and COM1. An optional second serial port costs \$50.

You configure the board by copying the LIM EMS 4.0 driver to your hard disk and adding a line to your CONFIG.SYS file with the parameters you choose. Amazingly enough, that's all there is to it. You

don't even have to run your computer's SETUP program. Instead of storing its configuration in switch settings or an EEPROM (electrically erasable programmable ROM), the board reads the parameters in CONFIG.SYS every time you turn on the machine. It then detects the amount of memory you've plugged in, assigns some or all of it to EMM (expanded memory manager) if that's what CONFIG.SYS demands, and automatically backfills up to 512K of DOS memory. The software also automatically makes sense of two or more boards in the same computer.

This automatic method works only under DOS. If you intend to use the board with OS/2 or any other protected-mode operating system, you'll need to buy a \$159 hardware option called AUTOROM to configure the board via an EEPROM that retains the configuration when you turn off the machine. Much of the manual is devoted to setting up AUTOROM, but you can ignore those pages if you stick with DOS.

This board was by far the most troublesome to test of any in this roundup. Two samples wouldn't run at all in a standard IBM AT that worked perfectly with all the other boards. We got the board running in a second, identical AT, but the computer locked up when we ran the PC Labs LIM 4.0 compatibility tests. Profit Systems then supplied revised software that ran the tests without errors but with lackluster results. Nonetheless, you can be confident that Profit Systems will stand behind the Elite 16; it comes with a 5-year warranty.

Profit Systems' Elite 16 Plus HyperCache board is a nonstandard design that performs moderately well, but may have special advantages in nonstandard systems. If you hate hauling out the SETUP disk for your IBM AT, its software-only installation may make it the board to choose.

STB SYSTEMS INC.**STB RapidMEG**

by Robert W. Kane

Do you fit the bill? The ideal STB Systems RapidMEG customer needs lots of memory for monster Lotus 1-2-3 spreadsheets or OS/2, but doesn't need the very latest in LIM 4.0 capabilities. That customer also wants to save money; without RAM, the

The best LIM EMS 4.0 board for your 286 doesn't necessarily have the longest feature list. The fancier LIM 4.0 boards come with alternate hardware register sets for high-speed multitasking, but if that's high on your agenda, you might consider spending your money on a 386 machine instead of on a 16-bit LIM EMS board for your 286.

Most users of LIM EMS boards for 286 PCs want expanded memory for large spreadsheets or other single-tasking applications. For these users, the STB RapidMEG is the simplest and most economical choice. Although it lacks alternate hardware register sets, it outruns many of its competitors, comes with virtually switchless installation, and uses SIMMs for hassle-free expansion.

Also praiseworthy is Computer Elektronik Infosys's RAMflex, which costs only a bit more and includes alternate hardware register sets. The fastest LIM board tested in PC Labs, the RAMflex uses switches for installation but includes excellent software that makes the job easy.

If you're willing to pay an extra \$100 or so for a board with just about every feature in the book, AST's RAMpage Plus 286 fits the bill. And the pricey Above Board Plus 8 I/O from Intel lacks alternate register sets, but has superb switchless installation and software, optional I/O ports, and toll-free support.

For the most RAM per slot, consider Newer Technology's Concentration board. Designed primarily as an extended memory board (you need to add an optional module for LIM EMS support), it lets you pack 32MB of RAM in a single slot—without interfering with the slot next door.

Whichever board you buy, get a copy of Qualitas's *Move'EM* or Quarterdeck Office System's *QRAM* to get the most of the memory you paid for. These programs move TSRs out of DOS memory and into your expanded memory board—a trick otherwise possible only with 386 machines.

ADD-IN MEMORY BOARDS

LIM EMS 4.0



FACT FILE EDITOR'S CHOICE

STB RapidMEG

STB Systems Inc., 1651 N. Glenview Rd., P.O. Box 860657, Richardson, TX 75085-0957; (214) 234-8750.

List Price: With 8K RAM, \$399; With 512K RAM, \$649; With 2MB RAM, \$1,189.

Requires: IBM PC AT or compatible.

In Short: What the \$399 RapidMeg lacks in LIM 4.0-capable hardware, it more than makes up for in price. The efficiency of its driver and its performance and setup versatility make it the choice for anyone on a budget.

CIRCLE 497 ON READER SERVICE CARD

RapidMEG is priced at just \$399, making it the Volkswagen of memory boards—inexpensive, efficient, and frill-free.

What your \$399 will buy is a bare board that accommodates up to 8MB of RAM via 1Mb SIMMs, supports bus speeds of up to 12 MHz, and has memory partitioning capability for both expanded and extended memory. There's also a two-year warranty—twice as long as the industry standard, though not as impressive in this particular group of products—demonstrating that the only cheap aspect of the RapidMEG is its price.

Economy has its costs. The board doesn't have advanced LIM 4.0 capabilities such as alternate hardware register sets for multitasking (although the board will support alternate register sets in software), DMA paging, extra added software utilities such as RAMdisks, print spoolers, or disk caches, or optional ports for I/O. But these extras are not in concert with STB's mission: to offer a basic, economical and reliable memory board.

Installation of the RapidMEG is relatively simple and straightforward, once you get accustomed to the almost-unreadable white-on-gray text used in the installa-

tion software (which the company reports is being revised). First the software asks for the sizes of the expanded and extended memory partitions, and then the system tests the optimal bus width and speed for your particular setup. You can also select a complete memory diagnostic test to check for any bad RAM installed in the system. When you're through setting parameters, just flick on the toggle switch extending out of the back of the board to enable the

EEPROM (electrically erasable programmable ROM) and signal your system to recognize the board. To reconfigure after adding additional memory, all you do is turn off the switch and rerun the installation software.

While some manufacturers decry the use of switchless installation techniques, citing the use of these boards in non-DOS environments, STB has gone to great lengths to ensure that its board can be installed from a floppy disk in a system containing as little as 384K of system RAM. As long as you have DOS on a floppy disk, you will be able to install and use the RapidMEG.

If you're searching for more space to move your data back and forth, the STB Systems RapidMEG is worth a look. Like the people's car of old, its efficiency and reliability will serve you for a long time at little expense.

Joseph J. Antinori is an editorial assistant of PC Magazine. Robert W. Kane is a project leader at PC Labs. Edward Mendelson is a contributing editor of PC Magazine. Winn L. Rosch is a contributing editor of PC Magazine.



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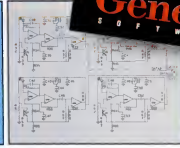
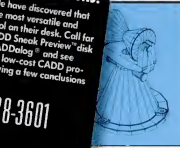
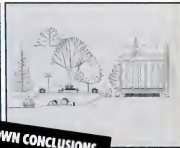
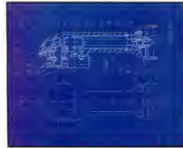
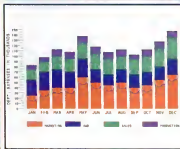
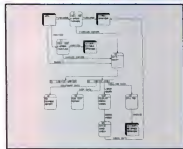
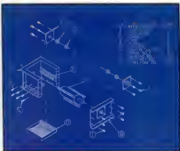
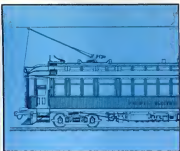
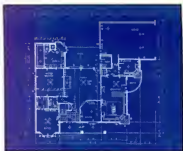
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NOVELL'S NETWARE 386

by Frank J. Derfler, Jr.
and M. Keith Thompson

**The king of workgroup
computing has released
the first true network
operating system:
Novell's NetWare 386.
Painless networking
may soon be on the not-
so-distant horizon.**

You know all about Novell's *NetWare*. Odds are your company is using *NetWare* 286 already. In fact, you've probably been waiting since the second quarter of 1989 for *NetWare* 386 to be released, while you stare longingly at the powerful hardware that sits underutilized in your corporate suite. Your vigil is finally over, and the results are in: *NetWare* 386 is the rightful inheritor of its predecessor's networking empire.

NetWare's presence in the PC-based network operating system market is an imposing one. Depending on how you construct the sample group, Novell's *NetWare* holds between 40 and 60 percent of the market, making it the standard for network operating systems today. People at both 3Com and IBM freely admit that they sell more of their Ethernet and Token-Ring adapter cards to run under *NetWare* than under their own network operating systems. For a stiff competitor with an almost

overbearing market share, Novell has surprisingly few critics.

Because of *NetWare* 386's origin as a 286 system, its latest version number is a little confusing. Version 3.0 is the first release of *NetWare* 386 but the third major version of *NetWare* overall. According to Novell, *NetWare* 286, now in Release 2.15, will not reach Release 3.0 level. Version 3.1 of *NetWare* 386, which is discussed later, is slated for the first quarter of 1990.

NetWare 386 and existing *NetWare* 286 systems have a lot in common. If you manage a Novell network today, you'll be able to install a *NetWare* 386 server in minutes. The management structure remains the same, and all the familiar utilities operate in the same ways. *NetWare* 286 and 386 servers can coexist on the same network, and you don't have to make any changes to the existing client workstation software in order to give individual users access to

both types of *NetWare* servers.

The differences are primarily improvements: easier installation, huge file storage capacity, better throughput, and the ability to run programs called *NetWare* Loadable Modules (like e-mail gateways and IBM's SNA protocol) on the server instead of on separate dedicated networked PCs. Novell intends for NLMs to be developed primarily by third-party vendors. None of these are yet available, though Novell has converted a couple of its own programs for current use.

NEW KID IN TOWN

Like *NetWare 286* before it, *NetWare 386* was designed from the first line of code as a network operating system. Competitors such as the various versions of Microsoft's *LAN Manager* and Banyan's *VINES* are add-ons to existing general-purpose multitasking and multiuser operating systems, respectively. That means they aren't as tightly integrated and in practice don't perform as well as *NetWare*.

PC Labs' hands-on tests show that the first release of *NetWare 386* is robust and full of promise. The data throughput was about 20 percent faster than that of *NetWare 286*, and the degradation under heavy load was less. But progress doesn't come cheap. Its \$7,995 price tag classifies *NetWare 386* as a high-end product. If you need large capacity, you get what you pay for. *NetWare 386* offers the data storage capacity of a minicomputer with faster response and a lower price.

Today, *NetWare 386's* speed, huge storage capacity, and minimum degradation under heavy loads will make your networking life a lot more pleasant. Tomorrow, it will serve as a rich environment for the introduction of a new generation of server-based applications for the i386 and i486. The only caveats are that the internal applications leveraging its power are yet to be released, and you'll probably want to buy a lot of expensive top-of-the-line hardware to act as your *NetWare 386* server. You're not going to spend \$7,995 on a network operating system only to run it on a garage-sale 16-MHz 386.

UTAH ROOTS

Back in 1982, in a small office by the steel plant in Orem, Utah, Ray Norda, Judith Clarke, Craig Burton, and programmers from a company called Superset figured out that PC networking could grow from a ho-hum capability to a multibillion-dollar industry. At the time, companies in the

NETWORK GLOSSARY OF ACRONYMS & TERMS

AFP (AppleTalk File Protocol)

Apple's network protocol, used to provide access between file servers and clients in an *AppleShare* network. Also used by Novell's products for the Macintosh.

API (Application Program Interfaces)

A set of standard software interrupts, calls, and data formats used by application programs to start network services. For example, applications use APIs to call services that transport data across a network.

disk duplexing

A technique used by System Fault Tolerant *NetWare* to write data simultaneously to two hard disks using different controllers.

disk mirroring

A technique used by System Fault Tolerant *NetWare* to write data simultaneously to two hard disks using the same controller.

hot fix

A program that dynamically marks defective blocks on the hard disk so they will not be used.

IPX (Internet Packet Exchange)

NetWare's native transport protocol, used to move data between server and/or workstation programs running on different network nodes. IPX packets are not related to packets used in Ethernet and similar systems, nor to the tokens used in Token-Ring.

kernel

The heart of the operating system, containing the basic I/O functions but not transport protocols or services.

multiple name spaces

The association of several names or other file-related pieces of information with the same file. This allows renaming and designating of files for dissimilar computer systems such as the PC and the Mac.

NCP (NetWare Core Protocol)

The data format of the requests *NetWare* uses to access files.

NFS (Sun Microsystems' Network File System)

The standard Unix file system for mul-

tivendor environments.

NLM (NetWare Loadable Modules)

Applications and drivers that run in the server and can be loaded or unloaded on the fly. In other networks, such applications would require dedicated PCs.

Named Pipes

A channel used for communication between applications across the network. It includes a relatively easy-to-use API, providing application programmers with a simple way to allow applications on different machines to communicate over the network.

ODI (Open Data-Link Interface)

A standard interface for transport protocols, allowing them to share a single network card without any conflicts.

OPT (Open Protocol Technology)

Novell's strategy for complete protocol independence. *NetWare* supports multivendor hardware with this approach.

RPC (Remote Procedure Call)

A set of software tools designed to assist developers in creating distributed NLM applications. These tools automatically generate the code for both sides of the program (client and server) and let the programmer concentrate on other portions of the application.

SFT (System Fault Tolerance)

The capability to recover from or avoid a system crash. Novell uses a Transaction Tracking System (TTS), disk mirroring, and disk duplexing as its system recovery methods.

STREAMS

An architecture introduced with Unix System V, Release 3.2, that provides for flexible and layered communication paths between processes (programs) and device drivers. Many companies market applications and devices that can integrate through *STREAMS* protocols.

SPX (Sequenced Packet Exchange)

An enhanced set of commands implemented on top of IPX, allowing more functions—one of which is guaranteed delivery.

TTS (Transaction Tracking System)

A log of all file activity. Includes a systematic roll-back of data files. ■

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including menus, macros and files.

There are also IBM® mainframe and VAX versions, (how long will that take

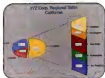
Lotus?) and all of them are backed and supported by the world's leading independent software company.

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For most users, it just doesn't compute.



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NOVELL'S NETWORK 386: SUMMARY OF FEATURES

	NetWare 386, Version 3.0	3+Open LAN Manager, Version 1.1	NetWare 286, Version 2.15
GENERAL INFORMATION			
List price	\$7,995	\$3,495	\$4,995
Peer-to-peer resource sharing	■	■	□
NETWORK OPERATIONS			
Server			
Special hard disk format	■	□	■
Fault tolerance	■	□*	□
Maximum number of network cards bridged	16	5	4
Maximum number of simultaneous log-ons	250	1,000	100
Server software			
Number of disks	10	12	35
Additional operating system required	None	OS/2 (included)	None
Supports disk caching	■	■	■
Workstation software			
RAM available for applications	566K	520K to 589K	540K
RAM available with NetBIOS	516K	520K to 565K	516K
Compatible with OS/2 workstation	■	■	■
File system limits			
Concurrent open files per server	100,000	8,000	1,000
Volumes per server	32	26	32
Physical drives per volume	32	1	1
Physical drives per server	1,024	12	32
Allows files to span multiple drives	■	□	□
Maximum file size	4GB	2GB	255MB
Maximum volume size	32TB	4GB	255MB
Maximum physical RAM	4GB	16MB	12MB
Maximum total disk storage	32TB	7.5GB	32GB

■—Yes □—No MB = megabytes, GB = gigabytes, TB = terabytes
* This feature is available via a third-party product.

ADMINISTRATION

- Network administration
 - Keeps historical error/status log
 - Keeps accounting information by user or resource
 - Adds or deletes network resources while network is running
 - Reports number of bad packets
 - Reports network errors
 - Monitors open files
 - Shows names of users logged on
 - Shows percentage of server being used

Security

- Access to network resources can be determined by membership in a group
- Passwords can be associated with network resource names
- Software sends encrypted passwords over the network
- Access can be granted via level
- Access can be controlled by time and date

USER FEATURES

- E-mail service
 - Store-and-forward e-mail system
 - Can attach binary files to messages
 - Allows rude messaging
- Printing
 - Software handles print spooling
 - User can modify print queue
 - Maximum number of printers supported
 - Workstation printers supported
 - Software supports downloading to

networking business were mainly interested in selling hard disk drives, but the mission of the company they founded was to market an operating system with good features and performance, and to do everything possible to create the environment it needs to run.

Over the years, that strategy has remained consistent; no matter how much pressure has been put on Novell to turn a quick profit, President Nords has kept his company's focus on the bigger goals of providing software, systems tools, and support. Instead of using the IBM-inspired strategy of "account control," Novell has gone to great lengths to build outside support and even to stimulate competition. It even entered the hardware market several

times to develop new products or to drive down prices.

NetWare 386, Version 3.0, is the seventh revision of a product that services 4,000,000 people on 400,000 LANs. It's a product family with a habit of setting milestones. Novell was the first company to introduce a network operating system for true file sharing, as opposed to simply writing private unshared files to a shared platter on a hard disk. Novell led the way to hardware independence by providing *NetWare* with the ability to run on 30 different brands of networks and 100 different network adapters by means of a protocol-independent architecture for all *NetWare* services: Open Protocol Technology (OPT).

Novell has always been a company that sets goals, and over time it has accumulated a good track record for meeting them. That is important to keep in mind, because a lot of the appeal of *NetWare 386* comes from the promises that Novell makes about releasing future add-in products for *NetWare 386*.

NETWORK UNRAVELED

A true 32-bit network operating system, *NetWare 386* is designed for use with the i386 and i486 processors. While it operates both processors in their protected modes, *NetWare 386* takes further advantage of the advanced features of the i486 by executing longer instructions (more commands per CPU cycle) than *NetWare 286*

CONNECTIVITY

NOVELL'S NETWORK 386

NetWare 386,
Version 3.0

3+Open LAN
Manager,
Version 1.1

NetWare 286,
Version 2.15

ISOT	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
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does. Two other PC-oriented network operating systems, Banyan's *VINES* and DSC Communications' *NEXOS*, also operate the 386 processor in its protected mode. *NEXOS* has a built-in data management capability that gives it very fast performance in certain applications, and *VINES* has powerful communications capabilities, but neither product has a 486 capability, and neither enjoys the wide support of *NetWare*.

The product that logically should be the strongest challenger to *NetWare*'s market dominance, Microsoft's OS/2-based *LAN Manager*, has made a very small impression on the market and continues to receive the cold shoulder from buyers. Powerful companies like 3Com, IBM, DEC, and

DCA either are marketing or will market *LAN Manager* products, and together these pose a strong potential threat to *NetWare*'s market share. But the first 32-bit release of OS/2 is only partially 32-bit, because a conversion layer is needed for translating from 16- to 32-bit and then back for some functions. So unless some special changes are made to OS/2 running in *LAN Manager* services, it still won't be as technically sophisticated as Novell's *NetWare 386*.

THE SYSTEM YOU WON'T OUTGROW

Many of us can remember the days when we thought a 20MB hard disk would always handle all of our storage requirements—and then we discovered how fast a hard drive fills up. Although it is tough to predict the computer requirements of the future, it's unlikely that you'll outrun *NetWare 386*'s disk storage capabilities anytime soon.

Novell moved into the minicomputer arena with its new file system. The file system in *NetWare 386* keeps all its old tricks of elevator seeking, I/O queuing, and disk caching—similar to features that competitors such as *LAN Manager* offer, but better implemented in *NetWare* because of its unique status as a true network operating system.

On top of that, *NetWare 386* adds huge capacity. Sporting a maximum disk space of 32 terabytes (1TB = 1,000,000 megabytes), *NetWare 386* is able to handle the data load of even the largest companies. Volumes can span multiple disk drives, and files can grow as large as 4 gigabytes (1GB = 1,000 MB). That means you can

spread a single data file across several hard disks and your application will never know the difference.

Gone are *NetWare 286*'s 100-user and 1,000-open-file restrictions. *NetWare 386* allows each server to have up to 250 users and 100,000 open files. If a rare application requires 100 simultaneously open files (for example, multiple data tables, indexes, help files, and drivers), *NetWare 286* is limited to giving 10 users simultaneous access to that application. Under *NetWare 386*, 250 users can run a 100-open-file program with capacity to spare. And Novell has made provisions for adding more users in subsequent releases.

This directory listing shows *NetWare 386*'s "multiple name space" capability. The first part displays the Macintosh files with a short DOS name. An Extended Directory List command with the ".mac" parameter details the full Macintosh file information below.

VERBOS:JEN TEST TEMP

File	Size	Last Modified	Flags	Owner
FILESSO	1,350	5-14-89	0-40	1 E00
NETW31.222	0	5-14-89	0-40	1 E00
HELLO.718	10,103	5-14-89	0-40	1 E00
TEST28	241,769	8-20-89	0-40	1 E00
TEST28	128,483	7-20-89	1-75	1 E00

658,591 bytes in 5 files
671,744 bytes in 161 blocks

F:\>DIRTEMP\mac
VERBOS=JEN TEST TEMP

Macintosh Files

File	Size	Last Modified	Owner
Form group 9 Netware3 79	1,835	9-14-89	0-40 E00
TestFile 1 E00	223,183	9-14-89	0-40 E00
Selected files overview	16,113	9-14-89	0-40 E00

F:\>DIRTEMP

PC FACT FILE

NetWare 386, Version 3.0
Novell Inc., 122 East 1700 South, Provo, UT
84606, (800) 833-7693, (801) 379-5900.
List Price: \$7,995 (256-user version).
Requires: 2MB RAM, 386 processor, DOS 3.0
or later.

CIRCLE 428 ON READER SERVICE CARD

PC FACT FILE

3+Open LAN Manager, Version 1.1
3Com Corp., 3165 Kilar Rd., Santa Clara, CA
95052, (408) 562-6400.
List Price: \$3,495 (unlimited user version).
Requires: 80286 or 386 processor; 4MB RAM,
or 2.5MB per OS/2 workstation, or 640K per DOS
workstation; OS/2 (included for server, required
for OS/2 workstations); DOS 3.1 or later.

CIRCLE 542 ON READER SERVICE CARD

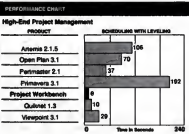
Autoschedule

New Products		Day	Resrc	26	3	10	17	24	3
MARKET ANALYSIS									
Plan Analysis									
Define Objectives									
Arrange Resource		6 JD	C					
Conduct Interview		Scope Group of projects Backup before Autoschedule? Yes							
Interview Corp		Include resource constraints? Yes							
Interview Opers									
Interview Marketing		6 LA							
Consolidate Findings		10 LA TB							CL
Utilization									
John Davis		4.0v JD		4.9	4.3	2.1	1.8	1.0	
Tom Benson		5.0v TB		0.5	2.6	4.5	3.4	2.4	
Larry Ashton		5.0v LA			1.0	3.9	4.1	6.1	
Total days				5.4	7.9	10.5	9.3	9.5	

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CONNECTIVITY

NOVELL'S NETWARE 386



BENCHMARK TESTS: NOVELL'S NETWARE 386

NetWare 386 is the fastest network operating system you can buy today, with maximum throughput figures over 50 percent better than what you got under *NetWare 286*. Novell's supremacy is hardly assured, however, since 3Com's new version of *LAN Manager* running on its new 3S/500 server is only a few percentage points behind.

The *Network Throughput Under Load* test loads network cards, media, and access protocols but places a small load on the server. While the timed station transfers files, load stations read and write 1-byte data files, creating a high volume of data packets and increased activity on the network.

The *Hard Disk Access Load* test heavily loads the hard disk and disk-caching system. Each load station randomly accesses its own 100K data file using 1K records while the timed station transfers files. This procedure tests how well the software handles the drive and the speed of the disk subsystem.

In the *Database Load* test, all stations share a 4MB data file and its index file during reading, looking, and writing tasks while the timed station transfers files. This test reflects the record-lookup speed of the system and the way it handles a number of random, simultaneous accesses to a common file.

These three tests each report the throughput recorded during the performance of a standardized task on the network. Each load station operates at a rate many times that of a PC in a typical heavy-use environment.

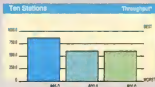
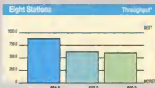
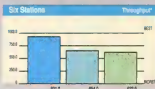
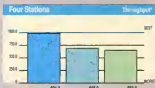
While loading the network with specific programs for each test, we run a general test program performing a sequential create, a sequential read, a sequential write, a random read, and a random write of a large file. The record sizes used in these activities systematically rotate among 16K, 4K, and 512 bytes. Usually a 1MB file is used, but this size may be adjusted for unusually fast or slow networks.

CONTINUES

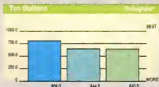


BENCHMARK TESTS: NOVELL'S NETWARE 386

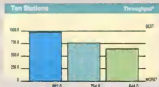
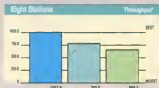
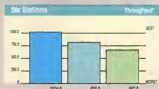
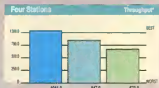
NETWORK THROUGHPUT UNDER LOAD



HARD DISK ACCESS LOAD



DATABASE LOAD



* Kilobits per second.

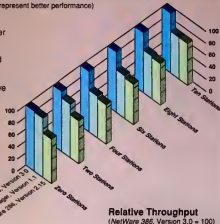
CONTINUES



BENCHMARK TESTS: COMPOSITE VIEWS

NETWORK THROUGHPUT UNDER LOAD:

(Taller bars represent better performance)



Relative Throughput

(NetWare 386, Version 3.0 = 100)

According to our tests, *NetWare 386* provides better throughput than any other LAN server software available at the time of the test. The large disk cache on the server showed a very high effective hit rate, although the load stations each randomly accessed and indexed files of over 4MB in the Database Load test. It is very unlikely that a properly managed *NetWare 386* server will ever be brought to its knees by application program requests. These tests did not, however, measure what effect running *NetWare Loadable Modules* might have on file server performance.

We ran *NetWare 386*, Version 3.0, on an IBM PS/2 Model 80 with 7MB of RAM, Novell's 32-bit NE/2-32 Ethernet adapter, and fast Core hard disks. The load stations were a mix of 386- and 286-based computers running at a minimum of 10 megahertz.

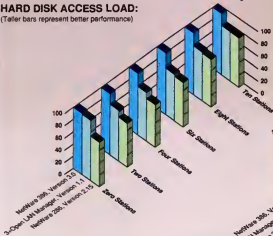
NetWare 286, Version 2.15, was run on a Core 386T Server with 7MB of RAM, Core hard disks, and a 3Com 3C505 Ethernet adapter.

3Com's 3+Open LAN Manager, Version 1.1, ran on a 3Com 3Server/500 with 8MB of RAM and an internal EtherLink adapter.

The workstations used 8-bit Gateway Ethernet adapters for the Novell tests and 3Com 3C503 boards with 3+Open LAN Manager.

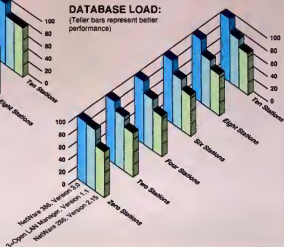
HARD DISK ACCESS LOAD:

(Taller bars represent better performance)



DATABASE LOAD:

(Taller bars represent better performance)



VOLATILE NLMs

The beauty of *NetWare Loadable Modules* is their ability to allow the powerful server to replace the dedicated network machines you must use today to house SNA gateways, electronic mail gateways, and communications servers. In the future, they will even let you house things like drivers for Micro Channel cards and products for network management, security, and work-group productivity. Once a decent set of

NLMs are developed, they'll really set *NetWare 386* apart from the pack. Similar applications have been developed for competing systems, but they are not as tightly integrated as *NetWare's* NLMs will be. The reason, once again, is that competing versions run on multitasking systems rather than true network operating systems like *NetWare*.

NLMs do have one major drawback: they run with and in the same machine as

the file server software. If the file server hardware malfunctions, you lose all the functions in it. By contrast, in most current *NetWare* configurations, where a computer other than the file server is the SNA gateway, if the file server goes down you can still use the gateway and some other services operating on separate machines on the network.

The only NLMs currently available are those converted by Novell: the familiar

ENDS

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and again...



G/Ethernet 16-bit
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and again.



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G/Ethernet features special communications and queueing software to maximize your data access. It also has four times the on-board memory compared to most other Ethernets. So heavy data traffic, like spreadsheet or database applications between PCs on the LAN, won't slow you down.



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utilities MONITOR and FCONSOLE, the print server from *NetWare 386*, and *Btrieve* software. Novell plans to provide other NLMs with release 3.1, however, including a variation of FCONSOLE, providing an authorized workstation with control of the server's screen and console. Version 3.1 will also include an NLM for Version 2.0 of the *AppleTalk Filing Protocol (AFP)* so that Macs can directly use the *NetWare* server. Since both *NetWare 386*

CONNECTIVITY
NOVELL'S NETWARE 386

3.1 and AFP 2.0 use the Unix STREAMS architecture, the data exchange won't use midlevel translation like the present Novell service for Macs.

To spur third-party development efforts, Novell is releasing *Programmers Workbench*, which has software tools, technical documentation, and a pre-release copy of *NetWare 386*, Version 3.1.

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If you build LANs for a living and your profits don't follow this line, you're not making much of a living in LANs. ARC has a line of LAN cards, prices that will help you turn green on LAN hardware. They're all FCC and approved. We'll meet NOVELL your price/quantity needs and be your single source for workstations and file servers. So, for more green on LANs remember, the best line in the LAN biz is an ARC.



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CIRCLE 190 ON READER SERVICE CARD

PROGRAMMING FOR NETWARE 386

Besides providing vendors with what they need to write NLMs, the *Programmers Workbench* includes all the tools necessary to create distributed applications for *NetWare 386*. The C Network Compiler comes complete with the 286 Watcom C Compiler and Linker, a C graphics library, the *Btrieve* library, the Express C editor, the *NetWare API Library*, and a windowing debugger. Programmers can use these tools to create DOS- and OS/2-based workstation front ends for accessing the server applications. For creating NLMs, Novell provides the C Network Compiler/386. It has all the same functions as the regular compiler but is specific to the i386 and NLMs. Along with these compiler packages Novell includes *NetWare* Re-

Programmers Workbench includes software tools, technical documentation, and a prerelease of *NetWare 386 3.1*.

note Procedural Calls for *NetWare 386* and the *NetWare* STREAMS specification.

Another feature of the programmers' tools is the NLMs' ability to access the kernel of *NetWare 386* if necessary. This is a terrific capability for programmers, but it's akin to giving a lunatic a razor and telling him to keep it away from his neck. Keep in mind that if the NLM crashes, it could potentially bring down that file server. But a lot of applications need to get that deep into the operating system in order to perform, making the ability to take that risk an interesting move on Novell's part.

Because of this access to the kernel, a book called *The NetWare Theory of Operations* is included with the *Programmers Workbench*. This volume provides warnings to developers about actions inside the kernel that could bring down the server. To provide additional guidance, Novell also holds classes for NLM system developers.

DSC NEXOS 386 LAN BEATS NETWARE!

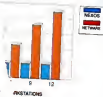
NEXOS is the clear winner!
NEXOS 386 beat NetWare® in operating system benchmark tests performed and guaranteed by the Lanquest Group, an independent test lab for the LAN industry. The results reveal the truth about NEXOS' superior performance over NetWare. In fact, NEXOS proves to be as much as **SIX TIMES FASTER THAN NetWare.**

Fast!

In real-world, user traffic environments on industry standard hardware using well accepted, multi-user applications for database, spreadsheet and word processing, **NEXOS** **beat NetWare in performance** **by an advantage of as much as 600%.** You'll work faster and expand LAN with confidence when you choose DSC NEXOS 386.

WORD MULTI-USER STRESS TEST

Smaller is better!



and consistent performance using a Compaq 386/25 workstations running a word benchmark.

re!

tion logging to the server's tape drive. With NEXOS your critical data is safe!

Flexible!

NEXOS gives you the flexibility, power and connectivity of **100% DOS and NETBIOS application compatibility.** Run all the applications your users demand and have access to UNIX, SNA hosts and the public network.

With all this power it's likely you'll want to put lots of data on-line. NEXOS' **large-drive support** provides access to virtually unlimited disk storage.

The unique disk handler makes multiple hard drives appear as one, providing contiguous access across multiple drives.

Connecting to your existing workstations is a breeze.

NEXOS is more than just a workstation interface. It supports XT, PS/2 and other configurations and is the choice of many network architects.

Network topologies: **Ethernet, ARCnet and Token Ring support is standard with every NEXOS LAN!**

CIRCLE 263 ON READER SERVICE CARD



NetWare

NEXOS blasts through performance barriers!

Easy!

NEXOS' power has been harnessed with an easy to use menu system that will have the system's administrator and users **up and running in minutes.** Simple instructions, familiar, DOS-like commands and DSC technical support means your NEXOS LAN system will work for you — for the users — and for your company.

NEXOS 386 is another quality networking product from DSC, a **\$340 million leader in advanced communications.** From your desk-top to around the world, DSC is delivering the quality networking solutions you demand!

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Fax: 408-954-5158



The DSC NEXOS 386 LAN Operating System



DSC Communications Corporation

THE REAL COST: HARDWARE

If you think the price of *NetWare 386* is high, wait until you add up the cost of the hardware necessary to run it. One of Novell's priorities is performance, so the company recommends running its system on an IBMPS/2 Model 70 or Model 80 or a Compaq Deskpro 386/33 for the best response time. The applications Novell foresees operate best if the network interface cards have a 32-bit path to the data bus, making the software a perfect match for EISA-bus machines—that is, when the hardware becomes available. If you add the cost of the 6MB to 8MB of RAM needed for efficient operation of *NetWare 386*, as well as two massive disk drives to take advantage of the high dual-drive storage capacity and SFT features, your hardware cost skyrockets to over \$25,000.

As for today's hardware purchases, *NetWare 386* currently supports only a few LAN adapters in the server. Still, the initial selection is wide enough to let you connect all existing mainstream networks to a Version 3.0 server. Until more drivers become available, you will be limited to using cards like Novell's NE/2 and IBM's Token-Ring in a Micro Channel server, or Novell's NE-1000 and IBM's Token-Ring in an AT-bus machine.

PLUG AND PLAY

Installing *NetWare 286* was such an impossible task that it was elevated to an art form. Value-added resellers boasted of their installation skills like old-time seamen asserting their superiority at climbing halyards during a storm. The process entails making selections from a bewildering set of menus and options and then using Novell's utilities to link software modules and compile the operating system. You can make certain kinds of changes to the configuration at the server, but you must completely regenerate and reinstall the software for other types of changes.

NetWare 386 suffers from none of these inconveniences. To bring the server to life, the system administrator needs to know what type of network card and what type of hard disk are installed. That's it. We installed the operating system and had users logged on in less than 20 minutes, not counting the time necessary for preparing the hard disk. This is a far cry from the several hours needed to bring up a *NetWare 286* server. Novell would do well to apply the same effort to simplifying the generation of the *NetWare* shell software for workstations. You still must use the time-

consuming select-and-compile routine for network shells.

NetWare 286 and *NetWare 386* differ in the way the server boots from the hard disk. *NetWare 286* boots from the *NetWare* partition on the hard disk, whereas *NetWare 386* boots from a DOS partition (or floppy) and then runs the *SER-VER.EXE* program, which accesses the *NetWare* partition. Since *NetWare 386* cannot boot from the *NetWare* partition, Novell recommends creating a 1MB DOS partition for booting. This loads the network operating system approximately ten times as fast as the old "cold boot loaders" familiar to Novell system managers.

**Installing NetWare
386 is far easier than
installing 286. The
system administrator
must know what type
of network card and
hard disk are installed.**

Some of the early Intel i386s made in 1986 and 1987 can't correctly multiply 32 bits of data at a time. So as a safeguard, *NetWare 386* attempts a 32-bit multiply during installation. If your system fails the test, you receive an error message and must obtain an i386 that is operating properly.

MIGRATION EASE

The good news is that you can upgrade from *NetWare 286* to *NetWare 386* on the same server and keep all of your user IDs, privileges, and other management information. The bad news is that somehow you have to save and restore all program, bindery, and data files.

The process of upgrading from a *NetWare 286* server should be easy—unless you have a ESDI hard disk and controller, as many modern servers do. Unfortunately, the ESDI disk driver in *NetWare 286* has a bug that erroneously reports an extra cylinder on the drive during an up-

grade to *NetWare 386*. When *NetWare 386* tries to access the nonexistent cylinder, it becomes confused and exits. The only solution is using the Novell utilities to do a new low-level format of the hard disk. This obstacle was fixed in *NetWare 286* packages that are currently on the shelves, but owners of older *NetWare* are out of luck.

If you have extra hard disk space available on another server or tape backup, you can copy the files on the system you want to upgrade. After installing *NetWare 386*, run the Upgrade program. It converts all of your *NetWare 286* system information, including passwords, user rights, and mappings, to the new format.

WHAT'S NEW

Aside from its ability to use NLMs, the single most innovative feature of *NetWare 386* is Dynamic Resource Configuration. Both the system administrator and the users benefit from this artificial intelligence-type feature. *NetWare 286* required the system manager to allocate specific amounts of memory for directory caching and routing buffers. The server had to be taken down and run through a series of customization menus whenever new applications or users were added. With *NetWare 386*, not only can these values be changed with the server up, the software itself determines what the optimum values should be and corrects them on the fly. A few other new or enhanced features are also of interest.

The new Multiple Name Spaces feature allows *NetWare 386* to handle files from different operating systems and different international language versions more easily. *NetWare 386* stores different file names for the same file if it will be used by different operating systems. For example, a *Microsoft Excel* file used by both Windows and Apple versions will have two names when stored on the server.

The file-salvaging feature allows the saving features provide added protection over what *NetWare 286* gave. The file-salvaging feature has two options for deleting files. One option automatically deletes deleted files, and the other option deletes files until *NetWare 386* runs out of space. As *NetWare 386* purges on a first-deleted file basis, the system manager can delete files at any time. Saving files by letting the user delete a file from the

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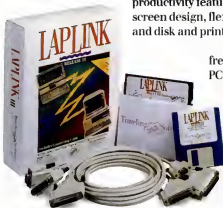
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CONNECTIVITY
NOVELL'S NETWORK 386

crypting passwords on the server, Novell now encrypts them on the wire, preventing network analyzers—like Network General's *Sniffer*—from reading what the workstation sends to the server.

The new NLM versions of the Print Server and *Btrieve* provide some new benefits. The print server now supports printers attached to local workstations. It can manage up to 16 printers on the network. This flexibility lets organizations do high-volume printing at more-convenient, more-secure locations. But remember that several third-party companies offer utilities that give similar capabilities to *NetWare 286*, so distributed printing isn't sufficient reason to upgrade to the 386 flavor of *NetWare*. In its new NLM incarnation, the familiar *Btrieve* software, Novell's key-indexed record manager, is the back-end processor for the new client/server computing model. It is optimized for the i386.

Since *NetWare 386* is an open environment, a smart employee could write an NLM that would dig up all the security information associated with the server. Recognizing this possibility, Novell includes the Secure Console option, restricting any-

**The NLM version of
the Print Server now
supports printers
attached to local
workstations.**

one but the system administrator from adding NLMs or server applications.

Another feature making the system manager's life simpler is the new Workgroup Manager classification. As the name implies, this person has supervisory privileges over the users assigned to his or her workgroup.

We stressed the value of Message Handling Services (MHS) in "LAN E-Mail: Spreading the Network News" in the September 26, 1989, issue of *PC Magazine*. The multitasking feature of *NetWare 386*

gives MHS the ability to become an NLM in the server, thereby saving a PC on the network that would otherwise have to be dedicated as an MHS server. Since the MHS files are kept on the central file server, adding the MHS NLM to the server enhances performance, reduces the network traffic, and doesn't affect reliability.

Some 3.0 additions, such as encrypted transmission of passwords and significantly improved printer sharing, will be welcomed by users with certain kinds of installations and ignored by many others.

THE TORTOISE AND THE HARE?

Even though it's ahead in the race for market share of the PC-based LAN software market, Novell must hear footsteps in the grass behind it. Microsoft and a band of huge and merely large companies are trying to beat the folks from Utah on their own LAN turf.

Microsoft's OS/2 operating system achieves multitasking and therefore is inherently a better basis for a server than DOS is. For this reason, Microsoft released *LAN Manager*, an OEM application for OS/2, in early 1989. The program will be packaged and sold by major companies

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CIRCLE 203 ON READER SERVICE CARD

(including IBM, HP, NCR, DEC, DCA, and 3Com) who want reliable LAN server software with guaranteed compatibility.

LAN Manager provides full file and print server services for MS-DOS and OS/2 client workstations on Ethernet, Token-Ring, and other network systems. Like *NetWare 386*, it can handle gigabyte-size files and heavy traffic loads. The first release of *3+Open LAN Manager* included a special version of OS/2 with disk caching and sophisticated file handling capabilities.

3Com codeveloped *LAN Manager* with Microsoft and its version of the product, called *3+Open LAN Manager*, is the most advanced available. (See "Building

with *3+Open* provides significantly better response than *NetWare 286*. Under some load conditions, 3Com's hardware-and-software combination package comes within a few bits per second of the throughput we achieved with a carefully groomed *NetWare 386* server.

All the *3+Open* workstations and servers use NetBIOS as their foundation proto-

col interface for communication between stations across the network. (*NetWare* supports NetBIOS at the workstation level.) The Demand Protocol Architecture (DPA) feature allows any station to load protocols for TCP/IP, DECnet, SNA, or OSI nodes, to exchange data in the appropriate manner with hosts or stations using the new protocol, and then to unload the protocol without rebooting the workstation. This is done without losing the *3+Open NetBIOS* con-

Our benchmark test results show that a 3Server/500 loaded with 3+Open provides significantly better response than NetWare 286.

Workgroup Solutions: 3Com's *3+Open LAN Manager*." February 28, 1989.)

In September 1989, too late for a complete comparison with *NetWare 386* in this review, 3Com released Version 1.1 of *3+Open*. We were, however, able to provide features-table and benchmark-test results from a fast run of this product just before we sent this issue into the production process.

3Com has enhanced its new version of *LAN Manager* with features that include the ability to use different communications protocols on demand, a client/server system for database and other applications, support for the Named Pipes transport layer protocol, and menus meeting the IBM SAA standards. The multitasking capabilities of OS/2 give *LAN Manager* the same ability to run server-based applications that *NetWare* gains with NLMS.

Additionally, 3Com released a new server specifically designed for *LAN Manager*, the 3Server/500. Our benchmark test results show that a 3Server/500 loaded

EDITOR'S CHOICE
1982 MainStreet
July 1989

K.I.S.S.*

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nection. A system administrator can automate the whole process from a batch file and make a wide range of connection alternatives available to relatively unsophisticated users without tying up a lot of available RAM.

Lotus, Ashton-Tate, Oracle, and Microsoft have demonstrated or released applications that use 3Com's client/server system. The client/server system is a concept similar to Novell's NLMs. In both architectures, applications that otherwise would run on workstations run efficiently on the server. If an application such as a DBMS needs a lot of data from the file

**Lotus, Ashton-Tate,
Oracle, and Microsoft
have demonstrated
applications that use
3Com's client/server
system, which is
similar to Novell's
NLMs.**

server, then it makes sense to locate it in the file server and reduce the traffic on the network.

Novell uses the NLMs for a wide variety of tasks, and it hopes for innovative uses of server-based applications beyond the functions of a database server. 3Com is initially focusing on database-server applications.

In a database-server system, software in the workstation sends requests for specific data or reports to companion software running in the file server. The server-resident software takes care of the indexing, sorting, and other file-handling tasks that today are done by funneling big files down the network cable to the workstation for processing.

3Com bundles the latest version of 3+ Open LAN Manager, including the CSS capabilities, with the 3Server/500 and a 3Com 3Station/2E diskless workstation; the package is priced at \$21,495. Unbun-

died, it's less costly than the *NetWare 386* package: \$3,495 for the unlimited-user version.

If the collection of companies that make up the *LAN Manager* colossus move their bulk in step, they will crush a path through the market. 3Com's latest release seems to be trumpeting the charge. But meanwhile, *NetWare* just keeps racing ahead of the pack and racking up market share, with no sign of rest.

3.1 PREVIEWED

With *NetWare 386*, Version 3.0, as the foundation for development, Novell will be providing many enhancements with Version 3.1, expected in the first quarter of

NetWare 386 tries to be everything users and application developers could ask for. It provides tools for creating next-generation apps.

1990. While it's true that 3.1 is being released practically on the heels of 3.0, it's not necessarily advisable to wait. If you need over 100 log-ins, speed, and high capacity now, it's just as well to buy 3.0 and upgrade later.

Version 3.1 of *NetWare 386* adds two security enhancements: security auditing and encrypted backups. A security auditing function will keep a nonmodifiable audit trail of all security changes occurring on that server. The phrase "encrypted backups" means that whenever server backups are performed over the network, the data is sent and stored in encrypted form. When restored, the data is unencrypted only when it gets back to the server.

Since Novell is now competing with minicomputer vendors, the issue of network management has become very important. Management agents are tracking mechanisms built into critical areas of the operating system. These management agents keep track of server statistics and monitor specific server functions. When

certain predefined situations occur, the system manager is notified immediately.

THE NETWARE CUSTOMER

Because *NetWare 386* is a fully integrated operating system instead of an application running on top of an operating system, it differs significantly from applications running under Unix and OS/2. The overall design goal for *NetWare 386* is to provide the perfect server environment for networked applications.

NetWare 386 tries to be everything users and application developers could ask for in a network OS. For the users, the file system is fast, reliable, and spacious. System maintenance is simple, and the OS is expandable in terms of both the number of users and future hardware. It also provides programmers with the platform and all the tools for creating next-generation server applications.

The first organizations to purchase *NetWare 386* will be those needing more than 250MB of file space, 100 simultaneous log-ins, or 1,000 open files. There are other good reasons for buying the system now, before *NetWare 386*-specific applications are written. Increased throughput, ease of installation, workstation printing, and reduced system maintenance time are nothing to sneeze at. But at \$7,995 for the software, plus a significant investment in hardware, many companies that want these benefits will have trouble justifying the cost.

The main reason for OS/2's slow growth is the lack of killer applications. Novell seems well on the way toward avoiding this trap by stimulating the development of applications that will enhance the value of *NetWare 386*. The quality of the NLMs will in large part determine whether *NetWare 386* will fly or falter.

Novell is one of the today's most intriguing companies. Stimulating innovation in the area of workgroup computing, Novell instills the kind of confidence that makes even skittish brand specifiers comfortable. And once those impatient executives see *NetWare 386*, Version 3.1, they might even be willing to forget about *NetWare 386*'s late release. ■

Frank J. Derfler, Jr., is workgroup systems editor of PC Magazine. M. Keith Thompson is a product developer and consultant and a frequent contributor to PC Magazine.

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THE NORTON COMMANDER

VERSION 3.0



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Yet it's flexible enough to adjust totally to your particular style of working—even get out of your way entirely when you don't need to see it.

But since it can do so many things for you, you'll probably be seeing a lot of it.

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the application.

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—or the patience—to load and run the applications that created the files in the first place.

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MORE THAN JUST A REPLACEMENT

by Bruce Brown and Kellyn Betts

In the PC-equipped world, the keyboard has largely usurped the position of the longtime reigning champions, the pen and pencil. Unlike the typewriter before it, the PC-attached keyboard's invasion of the office has been nearly complete; such keyboards now grace the desktops of all from the lowliest thrall to the most august executive. And the ones you find usually came bundled with the computer.

While many people are extremely picky about the manual writing instruments they use, they're often far less finicky

**If your keyboard is
mysteriously stolen one day,
or—as is more likely—
it breaks, or you
decide that you can not
abide its mushy
feel or clacky noise for
another second,
you'll find it's both cheap
and easy to replace.**

about their keyboards. Perhaps it's because they don't realize these are replaceable; or maybe they're used to following corporate dictates regarding computer purchases. The fact that none of the top vendors offers a choice over what keyboard comes with its computers probably doesn't help matters.

Whatever the cause, the situation is unjustified. Replacement keyboards can be had for a relative pittance: these seven popular models range in price from \$55 to \$149. All you have to do is plug one of them into your AT-

or PS/2-compatible computer.

After all, how you feel about the keyboard you use (and how it feels for you) is pretty important. As ridiculous as it may sound to the well-informed PC user, the keyboard can determine how well (or little) people like their systems. This is echoed repeatedly through PC MagNet threads and our conversations with users. As your closest active link with your work and your computer system, the keyboard gives you the means to order it around and accomplish your tasks. If you spend a lot of time with that computer, having a keyboard that fits your needs can make it more pleasant. Additionally, if you rely on a high-end portable (like the 386 power portables reviewed in this issue), you may wish to plug in a "real" keyboard when

copies of that standard; others offer slight variations on it, usually incorporating features from earlier IBM keyboards. For example, all but the DataDesk offer larger, L-shaped Enter keys. Only the Northgate dares to deviate from the Enhanced model's arrangement of function keys (across the top) and stray from its 101-key limit. As you might expect, the key travel distances are all quite similar.

They look similar, but all of these replacement keyboards weigh substantially less and have significantly shorter cords than their IBM mentor. (Of course they also cost less, since replacement versions of that model go for a steep \$200.) Unlike that model, which claims no compatibility with any other model, these keyboards claim wide compatibility—with clone machines from Compaq and Dell and in some cases even with AT&T, Amstrad, Tandy, and Zenith computers. All of these replacements work with XT and ATs, though all but one require extra cables in order to be connected to a PS/2, and only one of those actually provides the cable.

BEGGING FOR BIAS

As highly as we prize objective reviews, we know well enough when it would be impossible to obtain them. So rather than sidestep personal reactions, we decided to emphasize them. Instead of hiring one reviewer to look at each of the four top keyboards, we decided to form a review panel. We enlisted ten frequent keyboard users at *PC Magazine*—including editors, project leaders, and free-lance writers—and supplied each one with the four most commonly used replacement keyboards. As always, each reviewer/panelist was given scripted instructions for assessing the products. Besides filling in the script, each person was to write a short review of each keyboard.

After the forms and reviews were in, we all got together for a group debriefing. There we learned how intensely personal keyboard reactions are. We expected different people to have diverging preferences in terms of the touch, feel, sound, arrangement, key size, and keyboard size they found desirable. What surprised us was that we couldn't even agree on what a light or heavy feel was: while one person called the Key Tronic Professional Series KB-101 Plus "stiff," another called it "scratchy" and others deemed it "too mushy." And a weight that many found

criminally light was ideal for use with one person's laptop pillow. We could find no consensus on priorities for these factors.

The one accord we did reach was that employers really should provide their computer users with a choice of keyboards. We envision a "pool" containing keyboards of different sizes, weights, and key tensions. Employees should be able to borrow from this pool in order to determine which models are right for them.

Because we used a review panel, the reviews that follow are in a format that represents a departure for *PC Magazine*. Following the description of each model is a short summary of how our panel felt about it. These reaction paragraphs are highly subjective, but we believe they will increase your appreciation of the importance of matching the keyboard with the user. You may even find them amusing—and perhaps that's the real departure from protocol.

CHICONY AMERICA INC.

Chicony KB-5161

A 101-key Enhanced keyboard clone, the \$89 Chicony KB-5161 from Chicony America is almost identical to the IBM Enhanced keyboard, at least in terms of its layout.

Like most clones, the Chicony has a key arrangement that differs from the IBM standard only in the size or location of three keys: Backslash, Backspace, and Enter. As with the original 84-key AT layout of these keys, the Enter key is larger and L-shaped, necessitating the miniaturization of both the Backspace and Backslash keys and the latter's relocation to the top row. The mechanical key-switch technology used in the Chicony is the type found in most of these keyboards, and the 2.1-ounce operating force it requires is average.

PC FACT FILE

Chicony KB-5161
Chicony America Inc., 1641 W. Collins Ave.
Orange, CA 92667; (714) 771-6151.
List Price: \$89.

In Short: A standard clone keyboard with little to recommend it or to get excited about. Its low price is probably its biggest selling point.

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you get the chance. (Most 386 portables come with replaceable keyboards, as do Toshiba's T3200, NEC's ProSpeed 286, and all GRID models.)

ENHANCING ENHANCED

Not counting the IBMs that are purchased to replace IBMs, the four largest replacement keyboard makers for PCs are Chicony, Key Tronic, EECO (Maxi-Switch), and Northgate. We've taken an in-depth look at one keyboard from each of these manufacturers. Additionally, we've provided information about keyboards from three other popular keyboard makers, DataDesk, NMB (HiTek), and Zeos.

Not surprisingly, the key layouts found in these keyboards are variations on the Enhanced keyboard that IBM has been selling with its computers since it upgraded the AT in April 1986. Some, like the model from DataDesk, offer straight



REVIEWERS' PREFERENCES

Name	System	Software used	Design preferences	Keyboards to choose for personal use	Keyboards to choose if buying for a company
Joseph J. Antinori, Editorial Assistant	PC's Limited 286	Lotus Express, Microsoft 1-2-3, XyWrite	Function keys at left, medium-firm touch, audible click	Northgate	Northgate, HiTek
Kellyn Betts, Associate Editor	IBM AT	Lotus Express, Microsoft Excel, XTree, XyWrite	Function keys at left, firm response, sturdy construction	Northgate, Maxi-Switch	Northgate, Maxi-Switch
Bruce Brown, Frequent Contributor	IBM AT	dBASE III, Lotus Express, Lotus 1-2-3, PC Tools Deluxe, WordPerfect	PC AT 84-key layout, function keys at left, tactile feedback, loud key click, durable construction	Northgate	Northgate, Zeos
Mary Kathleen Flynn, Associate Editor	IBM AT	ProComm, XyWrite	Backslash on top row after numbers, medium feel, medium sound	Chicony, Maxi-Switch	Northgate, Maxi-Switch
Bill Howard, Executive Editor	Compaq Deskpro 386/20, Dell System 310	Microsoft Windows/386 with: Agenda, Graph Plus, Hot Line, Lotus Express, Magellan, Microsoft Excel, PageMaker, XyWrite	Long cord, function keys at top, light touch, silent operation	Key Tronic	Northgate, Key Tronic, Turbo 101, individuals' choices
Robert W. Kane, PC Labs Project Leader	ALR FlexCache 25386	Lotus Express, Microsoft Excel, Microsoft Word, PageMaker, Publisher's Paintbrush, MS Windows applications	PC AT 84-key layout, function keys at left, heavy touch with tactile feedback, silent operation	Northgate, Maxi-Switch	Key Tronic (60%), Northgate (40%)
Stephanie K. Losee, Staff Editor	PC's Limited 200	Lotus Express, Lotus 1-2-3, XyWrite	Light weight, long cord, function keys at left, tactile feedback, audible click	None	Key Tronic
Jonathan Matzkin, Associate Editor	CompuAdd 286/12, Dell System 310	Instant Recall, Lotus Express, Lucid 3-D, PFS:First Publisher, ProComm, XyWrite	101-key layout, function keys at left, firm touch, audible click	Northgate, Chicony	Northgate (many), Key Tronic (few)
Bill O'Brien, Former PC Labs Project Leader	Dell System 325	Assorted games, Microsoft Excel, Microsoft Windows, Microsoft Word	None	Northgate, Key Tronic, Chicony	Northgate (for executives), Chicony (others)
Alfred Poor, Contributing Editor	Dell System 310, IBM-XT	Lotus Express, Maxthink, ProComm, Tapcis, XyWrite	Enhanced 101-key layout, function keys on top, medium-firm touch, nearly silent operation	Key Tronic, Maxi-Switch	Chicony, Key Tronic, IBM



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LAN TIMES
**READERS
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1989



Chicony

The Chicony KB-5161 follows the original 84-key AT layout for the arrangement of the Backslash, Backspace, and Enter keys, but its Enter key is larger and L-shaped, and the size of both the Backspace and Backslash keys is reduced.



The Chicony is of exactly the same dimensions as the Enhanced keyboard, but its plastic-encased contents weigh 36 percent less, at 3 pounds 6.5 ounces. Like all of these keyboards, it has a cable—at 80 inches—more than 30 percent shorter than the one that comes with the IBM. This is attached, however, to the opposite side of the keyboard—approximately 4 inches from the right corner. Two 1.25-inch legs extend 0.63 inch to raise the keyboard angle. It also has 2-inch-wide rubber feet for

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stability on the bottom front of both sides. The Chicony comes with a clear plastic top cover that you can use as a dustcover, although it doesn't seem sturdy enough to last very long.

The documentation consists of a simple quick-reference card. It indicates how to set the XT/AT switch—the only user adjustment—and gives the cable pinout for both AT/XT and PS/2 keyboards. The card also shows a conversion cable for PS/2s, but none is included with the keyboard. For templates (or pencils), the Chicom has a ridge that runs across the top of the key area of the keyboard.

In most respects, the Chicony is an average clone keyboard. In the area of warranties, however, it offers far less than its peers. Its one-year warranty is a third of the norm, which could put you in the replacement market sooner than you'd want to be there.

PANEL REACTIONS

Although Chicony's keyboard worked properly for all of the panelists—save for a few minor software glitches—most of us didn't like the KB-5161 and wouldn't choose one for our own desks. Our feelings about the Chicony were, well, mixed.

Even the reasons for our antipathy varied widely. Some panelists put down Chicony's popular unit for everything ranging from its right-sided connections (hard to reach from a tower unit usually tied to an Enhanced keyboard) to its tiny Backspace key to its overall flimsiness. Of course, some of the reviewers who generally liked the keyboard found it acceptable for the very same reasons that others maligned it.

In our poll, two of our experts, Bill O'Brien and Mary K. Flynn, said they'd purchase a Chicony for personal use, and O'Brien and Alfred Poor considered it a good purchase for a company.

Probably the most common reaction was one of disinterest. Seven out of ten panelists were basically nonplussed. "There's nothing really wrong with the Chicony," said Bob Kane, "but there's nothing really right with it either." Joe Antinori said, "I didn't have any problems using the Chicony; I just didn't like it very much." And Stephanie Losee added that it's "not a keyboard that inspires passion. Its middle name could be Simplicity, and it lacks any sort of style or character."

When our panelists did express strong feelings about the Chicony, they weren't

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always positive. Several remarked on the design innovation that creates an unusually large Enter key at the expense of the nearby Backspace and Backslash keys; Kellyn Betts found this "maddening" to work with. O'Brien likewise objected to the placement of the CapsLock key between the Left Tab and Shift keys. "Too quick a swipe at the Shift can put you into CapsLock mode without your realizing you've done it." Many noted the loudness of the tactile response—"clicky," said Bill Howard. And a fair majority questioned the sturdiness of the construction.

On the other hand, some of us did have

**A distinctive Chicony
design innovation
creates an unusually
large Enter key
at the expense of the
nearby Backspace and
Backslash keys.**

good things to say about this unit. Jonathan Matzkin declared, "Its excellent tactile response commands attention. I actually preferred typing on it to using several other keyboards." O'Brien said, "The key action is solid, with audio feedback occurring at the point of switch contact. Typematic ['automatic typing']—the repetition of characters when a key is held down] doesn't begin for approximately a second afterward, allowing even the laziest hands to recover without repeated characters." Flynn found it quite pleasant to use: "I just pulled out my old keyboard and put this one in. Six applications later, I hadn't uncovered a single incompatibility."

The consensus? The Chicony KB-5161 is a no-frills keyboard that will probably hold more appeal for the user who prefers a loud, clicking tactile response. Its compatibility and operation are essentially flawless, and it is a snap to install. It represents a reasonable value if you're already accustomed to the IBM AT keyboard layout and are more interested in price than warranty, innovation, or aesthetics.

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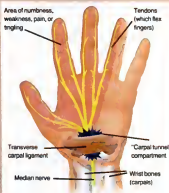
KEYSTROKER'S CRAMP

by John Carpi

If you type at a steady rate of 40 words per minute, a nominal pace in today's office environment, you are performing about 12,000 keystrokes per hour. Multiply that figure by 6 hours, after taking time out for lunch and coffee breaks, and you find that typical secretaries, word processors, and data entry clerks can easily move their fingers in the same motion about 72,000 times during the workday. Such repetitive motion can cause a number of crippling hand disorders, ranging from tenosynovitis to carpal tunnel syndrome.

No one knows how many people suffer from the syndromes, but their incidence is thought to be on the rise.

Even the National Institute of Occupational Safety and Health, whose job it is to keep track of such figures, doesn't have an estimate. But going by the results of several small surveys, we have evidence that about 17 percent of keyboard users can expect to be afflicted with the pain, numbness, and loss of finger control associated with



Carpal Tunnel Syndrome

what is known in the medical community as a nerve entrapment disorder.

The wrist is bounded on three sides by bones, while its underside is enclosed by the strong and inelastic transverse carpal ligament. Through the tiny opening in the center of all this tissue runs the median nerve, which provides sensation to the entire hand. The finger flexor tendons, which connect the fingers to muscles in the arm and operate like the strings of a marionette, also run through this tiny passage. Surrounding each of these tendons are thin, fluid-filled sacks called the synovial sheaths. When finger tendons are overused, as

in the case of many keyboard operators, the synovial sheaths fill with extra fluid to protect the tendons from irritation.

In normal wrists, the carpal tunnel is just big enough to accommodate the finger tendons and the median nerve. When the synovial sheaths swell, the median nerve can be squeezed against the wrist bones or the carpal ligament.

If your hands have ever ached after a long day at the keyboard you probably had a temporary case of tenosynovitis. Continued swelling can lead to carpal tunnel syndrome and the sharp hand pain it causes. If you must operate a keyboard for the entire workday, you can take some simple steps to lower your risk significantly. Try to keep your wrists straight while typing. Adjust your chair so that as you type your elbows are at the same height as your wrists.

Resting your wrists while you type is also very important. If the center of your keyboard is less than 2 inches thick (as are all those we reviewed) and you have enough room in front of it, you can rest

your wrists on the desk. If your keyboard is thicker than that or there is no desk space, consider purchasing a padded, contoured wrist rest to attach to the front of your keyboard. The Ontario, California-based Daisy Wheel Ribbon Co.; telephone (800) 472-4249 or (714) 989-5585 sells such an item.

Finally, many physicians suggest that you invest in a cheap digital watch—the kind that beeps every hour. Whenever it goes off, get up and relax your hands for 5 minutes.

John Carpi is a free-lance medical writer.

EECO INC.

Maxi-Switch Model ME 101

The smallest and lightest of these four replacement keyboards, the Maxi-Switch Model ME 101 is also the least expensive. This simple clone keyboard is sold solely through dealers for anywhere between \$55 to \$65. It's also a popular OEM keyboard among clone makers and is found (in some permutation or another) teamed with computers from Compaq, Everex, Lynk, MiniMicro, and PC Craft, among others.

The Maxi-Switch keyboard features a layout identical to the Chicony's. It is smaller and plainer but also more flexible than its similar sibling, as it allows the positions of its Ctrl and CapsLock keys to be switched (if you decide to switch them, new keytops are even included). Making the swap is easy—all you have to do is flip one of the two rocker switches on the keyboard's underside. A simple installation diagram sheet explains the settings for this switch (as well as the other one, which lets you select AT or PC/XT compatibility; PS/2s are never mentioned). This sheet is the only documentation that comes with the Maxi-Switch.

The only one of our test keyboards utilizing conductive rubber-dome technology, the Maxi-Switch operates relatively silently. Its operating force is the lowest of this bunch, at 1.8 ounces. Weighing in at just 2 pounds 13.5 ounces, the plastic-cased Maxi-Switch has a 78-inch cable attached to its rear center. Two 0.63-inch pop-down legs, one in each rear corner of the underside of the keyboard, raise and lower its backside. It comes with a three-year warranty.

PC FACT FILE

Maxi-Switch Model ME 101

EECO Inc., Maxi-Switch Division, 6701 S. Midvale Park Rd., Tucson, AZ 85746, (602) 294-5450.

List Price: \$55 to \$65 (determined by dealers). In Short: Small and lightweight, the Maxi-Switch is also low-cost. The only thing that really sets it apart from other simple clone keyboards is its ability to switch its CapsLock and Ctrl keys.

CIRCLE 428 ON READER SERVICE CARD



SUMMARY OF FEATURES: REPLACEMENT KEYBOARDS

(Products listed in ascending price order)

List price	Maxi-Switch Model ME 101 \$55.00 to \$85.00*	HiTek RT-101 \$60.00	Chicony KB-5161 \$89.00	Zeos RS \$89.95	Northgate Omnikey Plus \$119.00	Key Tronic Professional Series KB 101 Plus \$149.00
GENERAL SPECIFICATIONS						
Dimensions (WDH, inches)	18.5 x 8 x 1.5	17.25 x 8.13 x 1.5	19.13 x 8.25 x 1.5	18 x 6.5 x 1.75	20.25 x 7.25 x 1.75	19 x 8 x 1.5
Weight	2 lbs. 13.5 oz.	4 lbs. 4.0 oz.	3 lbs. 6.5 oz.	3 lbs. 1.0 oz.	4 lbs. 10.5 oz.	4 lbs. 7.0 oz.
Case material	Plastic	Plastic	Plastic	Plastic	Plastic top, metal base	Plastic
Cord length (inches)	78	84	80	84	84	72
Number of angle settings	1	1	1	1	1	1
KEY DESIGN						
Key-switch type	Conductive rubber-dome	Mechanical	Mechanical	Mechanical	Mechanical	Capacitive
Operating force required (ounces)	1.8	1.9	2.1	2.2	2.5	2.0
Key travel distance (inches)	0.15	0.14	0.16	0.14	0.09	0.15
KEYBOARD DESIGN						
Special keys (beyond the usual 101) None		None	None	None	Omni key, F13-F15	None
Exchangeable Ctrl and CapsLock	■	□	■	□	■	■
Extra caps for those two keys	■	□	□	□	■	□
Keyboard ridge for templates	■	■	□	■	■	■
COMPATIBILITIES						
Compatible with:						
IBM XT	■	■	■	■	■	■
IBM AT/Enhanced AT	■	■	■	■	■	■
IBM PS/2	□	□	■	Optional (\$15 adapter)	■	Optional (\$12 adapter)
AT&T 6300	□	□	□	□	■	□
Compaq Deskpro	■	■	■	■	■	■
Dell	■	■	■	■	■	■
Zenith	■	□	■	□	■	■
Clearly marked switches for choosing XT or AT	■	□	■	■	■	■
Stated incompatibilities	None	None	Amstrad, AT&T, some Tandy models	Amstrad, AT&T, Tandy, Zenith	None	None
WARRANTY						
Term	3 years	3 years	1 year	1 year	3 years	3 years
Means of service	Send unit to company	Send unit to company	Send unit to company	Send unit to company for replacement	Send unit to company	Call company for authorization, bring to local service center
Average turnaround time	2 weeks	2 weeks	1 week	1 day plus shipping	1 day plus shipping	10 working days
Shipping at vendor's expense	One way	Both ways	One way	One way	One way	One way
Means of shipping	UPS (Fed Ex at customer expense)	UPS (Fed Ex at customer expense)	UPS	UPS	UPS second-day service	UPS
Money-back guarantee	□	□	■ (1 month)	■ (30 days)	■ (10 days)	□

□—Editor's Choice ■—Yes □—No

N/A—Not applicable; the product does not have this feature.

* This keyboard does not have an official list price.

† IBM claims compatibility with no other vendors' machines.

PANEL REACTIONS

While no reviewer felt at the end of our test period that he or she would die if we took the Maxi-Switch away, it managed to garner the best overall response in our high-level opinion survey. Seven out of ten answered affirmatively to the question, "Do you like it?" The Maxi-Switch operates quite quietly, but unlike the case with Key Tronic's offering, most of our panelists were pleased with its feel. One might think, based on this information, that the Maxi-Switch would have run away with our accolades and recommendations.

Our purchasing poll, however, brought some contradictory feelings to light. Betts, Flynn, Kane, and Poor said they'd buy the Maxi-Switch for themselves—a respectable showing—but only Flynn and Betts thought it would be a smart purchase for a business—despite the fact that the Maxi-Switch may be found (at least sometimes) for the lowest price of any board we inspected.

Our panelists had virtually no problems with the way the keyboard functioned. One unit had defective indicator lights, but all keyboards operated without a hitch with our collective software library.

As with its layout twin, the Chicony, some of the complaints about the Maxi-Switch centered on its "improved" layout. Panelists Antinori and Lose lamented the keyboard's tiny Backspace key. Aside from this ersatz layout innovation, the unit follows the Enhanced model exactly, with all the positives of familiarity and possible negatives of functionality inherent in that design.

The hot topic for debate was the product's feel. Matzkin said he could sum it up in one word—"cheap"—but the unit developed loyal devotees. Betts admitted, "I'm enamored of its silent yet springy feel. It's a welcome change from the mushy feel normally associated with quiet operation." Flynn said, "Of the boards I've reviewed so far, this is my favorite. I like it better than the IBM AT board." Even tough-sell Kane chimed in: "Its soft, light, silent touch makes it seem as if you're typing faster than ever before." The unit has a distinctive feel, no doubt, but one that seems to drive people to extremes. In sharp contrast to Kane, Howard remarked, "I felt like a slower typist on this keyboard."

The value of this product's feel can be decided only by the buyer. Fortunately,

Turbo 101 \$149.95	IBM Enhanced AT \$199.00
-----------------------	-----------------------------

16.75 x 7.25 x 1.5	19.25 x 8.5 x 1.5
--------------------	-------------------

3 lbs. 9.0 oz.	5 lbs. 8 oz.
----------------	--------------

Plastic	Plastic
---------	---------

100	101
-----	-----

1	1
---	---

Mechanical	Capacitive
------------	------------

2.3	2.5
-----	-----

0.14	0.1
------	-----

None	None
------	------

■	□
---	---

■	□
---	---

■	■
---	---

■	□
---	---

■	■
---	---

Optional (\$7 adapter)	□
------------------------	---

□	†
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■	†
---	---

■	†
---	---

■	†
---	---

■	N/A
---	-----

None	†
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2 years	90 days
Send unit to company	Send unit to company

2 weeks	1 week
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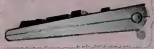
One way UPS	One way UPS
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■ (30 days)	□
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Maxi-Switch

The Maxi-Switch Model ME 101 has a layout identical to that of the Chicony, with the same deviations from the Enhanced configuration. The Maxi-Switch's Ctrl and CapsLock keys can be switched, however.



because of wide availability with dealers and in clone packages, you should be able to test-drive this model easily. In fact, detractor O'Brien noted that "the product's main strength is that any clone owner could replace his current keyboard with this one and not know the difference."

As the price leader, and with a large installed user base, the Maxi-Switch is a force to be reckoned with in this market. It comes very close to being a common-denominator keyboard, even though it lacks an IBM-like response and a weight that bespeaks quality. If you like this model's unique qualities, though, you can type all the way to the bank.

A PEEK BENEATH THE KEYS

The key to the click of a keyboard is in the key-switch technology it uses. The four key-switch technologies commonly found inside PC keyboards are mechanical, capacitive, conductive rubber-dome, and membrane switches. All but the last one are hidden under key caps, but you can't tell much about a keyboard's switch technology just by popping off the cap (and be careful if you try—you can break some keyboards by removing the key caps).

The two most popular technologies that use key caps—capacitive and mechanical—rely on what you would expect: a spring. Other keyboards use a conductive rubber dome instead. The compression loading of the spring or rubber dome (usually measured in ounces) largely determines how stiff or how mushy a key feels. What varies inside the keyboard is the way in which the spring's oscillations are transformed into key-strokes.

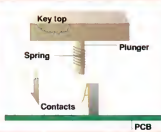
Which switch technology a vendor employs is governed by the conflicting pressures of the environment where a given keyboard will be used, how reliable it needs to be, and how much it will cost. Several vendors sell keyboards with a variety of switch technologies, depending on customer preference or application. The references to switch types in the following discussion refer only to the keyboards we tested.

Note that these keyboards can differentiate up to about 300 characters per second—more than any human hands can produce. The computer can't always process the signals that quickly, however. In order to assure that keystrokes can be saved for future execution, all of these keyboards send their signals into a special buffer on the motherboard that can hold up to 16 characters. The presence and activity of this buffer are unrelated to the key-switch technology a keyboard uses.

■ MECHANICAL SWITCHES

A mechanical key switch—a simple switch relying on contact between two conductive materials—sends a signal through a circuit board to the computer when a key is depressed.

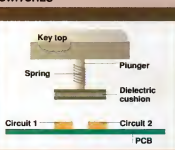
Though the design of such a switch is elementary, the cost can be high, depending on the contact material—often gold or gold alloy—it uses. Mechanical switches are reliable, have a relatively long life expectancy, generate an audible click, and (depending on the spring tension used to return the key) can have a very positive feel. The keyboards we tested from Chicony,



DataDesk, NMB, Northgate, and Zeos all use mechanical switches.

■ CAPACITIVE SWITCHES

Capacitive key switches are designed to detect a change in capacitance as a circuit is opened or closed; they don't make a mechanical contact between conductive elements. When a key press is



KEY TRONIC CORP.

Key Tronic
Professional
Series KB 101 Plus

Among the most expensive of these replacement keyboards, at \$149, Key Tronic's Professional Series KB 101 Plus may be worth its cost to many users because of its extremely customizable nature.

The most impressive feat of customization possible with the Key Tronic keyboard requires an added investment. For \$15, you can buy a kit that allows you to change the tension of all the white keys (letter and number keys) on the keyboard. The tension can be changed from the stock 2-ounce trigger level—lower than what most of these boards offer—up to 2.5 or 3 ounces or down to a feather-light 1 ounce, depending on your preference.

The keyboard also allows you to exchange the position of the Ctrl and Caps-

Lock keys. Additionally, it lets you disable the audible key-click tones some computers generate. These functions are both activated by setting well-labeled DIP switches located on the keyboard's underbelly. These switches also allow you to tell the computer which keyboard you're working with—you're allowed to choose Enhanced XT, AT, or PS/2, standard AT, PC, or XT, or Amstrad. The keyboard's extremely comprehensive manual—which even gives you suggestions for cleaning the keyboard—describes in painstaking

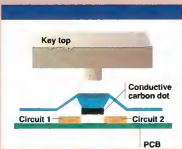
made, a dielectric (or nonconductive) cushion is pushed down, forcing the conductive elements farther apart (or closer together, depending on the design) to create a closed circuit.

Keyboards with capacitive switches are expensive to design, and they use relatively complex electronics, but they do have high reliability and a long life. These keyboards can have problems in harsh environments, especially in dusty or very humid workplaces. Traditionally, capacitive switches are used with springs on the plunger to control stroke pressure and feel; the IBM Enhanced-style keyboards follow this design. By contrast, the Key Tronic keyboard we tested uses capacitive switches with a rubber-domed sheet to control pressure and feel (this differs from a conductive rubber-dome key switch).

■ CONDUCTIVE RUBBER-DOME SWITCHES

In conductive rubber-dome technology, each switch has a carbon dot under the center of a raised rubber dome. When a key is pressed, the dome collapses, pushing the carbon dot down to complete a circuit between two contact pads.

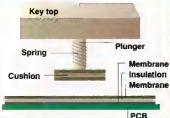
This type of switch is very quiet and can have a good feel, depending upon the composition of the rubber that is used. The rubber domes themselves can be individual pads under separate keys or, more commonly, can be arranged on a single thin sheet of rubber.



Conductive rubber-dome switches are relatively inexpensive and easy to assemble. Single-sheet rubber-dome keyboards give you some protection against spills, but if one part of the sheet goes bad you have to replace the whole thing. The Maxi-Switch keyboard we tested uses conductive rubber-dome technology.

■ MEMBRANE SWITCHES

Membrane switches consist of two layers of polyester film, each with a silk-screened pattern of conductive silver carbon ink. A layer of insulation between the two membranes has slight holes in strategic locations. When you push down on a key, a cushion squeezes the conductive membranes, causing them to make contact and close the circuit.



Membrane switches are the least expensive and have the shortest life expectancy among the common switch technologies. Keyboards that use them are quiet, have little or no feel, and are hard to repair, yet they are considered a good choice for harsh environments because the continuous rubber sheet that overlays the full key-switch set helps to keep out harmful dust, crumbs, and liquids. None of the keyboards we tested use membrane switches.

detail how to set these switches.

As you'd suspect from its name, this keyboard has 101 keys. The layout of these colorfully labeled keys is patterned after that of the IBM Enhanced keyboard, with just two exceptions besides the Ctrl/CapsLock swapability. The Backslash key, instead of being located above the Enter key and below the Backspace key, is below the Enter key, to the right of the Right Shift key. This way you get a large L-shaped Enter key, and the Backspace key remains two keys wide, but the



FACT FILE

Key Tronic Professional Series KB 101 Plus
Key Tronic Corp., P.O. Box 14687, Spokane, WA 99214; (800) 262-6006, (509) 928-8000.
List Price: \$149
In Short: A highly customizable keyboard, the Key Tronic Professional Series KB 101 Plus is a solid unit. Its ability to have its tactile response settings changed (using an optional kit) makes it especially enticing.

CIRCLE 427 ON READER SERVICE CARD

Right Shift key is smaller—slightly less than two key widths. As in the IBM Enhanced keyboard, the key-switch technology used inside the Key Tronic is capacitive, though the KB 101 Plus covers its springs with a rubber sheet, making it much quieter.

The KB 101 Plus's molded plastic case includes the standard pencil/template ridge and weighs a respectable 4 pounds 7 ounces. Its 72-inch cable (the shortest we saw, half the length of the one that comes with the original IBM keyboard) attaches

plates. A card advertises that you can even purchase a \$5 optional nameplate that fits on the upper-right corner of the board, just above the numeric keypad, in the space where most other keyboards have indicator lights, since on the KB 101 Plus the CapsLock, NumLock, and ScrollLock indicator lights are found on the keys themselves.

PANEL REACTIONS

In spite of this keyboard's eminent mutability and general fanciness, our panel was evenly split in its opinions of the unit: only half stated that they liked it. This may be because the KB 101 Plus was one of the few silent/mushy-response products we reviewed. In fairness, we must mention that though Key Tronic allows you to alter the tactile response of its keyboards through an optional kit, the company didn't send such a kit with our test units.

There was little dispute over the quality and workmanship of the KB 101 Plus. Apart from one reviewer who apparently had a defective unit, none of our experts uncovered any evidence of dysfunction or incompatibility in the keyboards; everyone agreed that it was top-notch, and it fared well in our purchasing poll. Howard, O'Brien, and Poor said they'd buy it for their own use (perhaps the highest compliment); Howard, Poor, Kane, and Losee said they'd be confident about buying this product for a corporate setting.

Accustomed to being critical, our staffers did come up with a range of complaints about this unit. Four singled out the shortness of the cable as a problem. Others disliked the placement of the cord on the back left-hand corner of the case. "Was the Key Tronic made for left-handed people only?" asked Flynn. "Plugging it into my CPU, which is stashed under the right-hand side of my desk, was exceptionally awkward. Once installed, the cord kept pulling the keyboard to the left of my desk. And then the board started sliding around."

Betts, Brown, and Kane unearthed an error in the manual that led them to believe they did not have to set DIP switches to begin operating. The manual claimed that the unit arrived preset for any machine that was previously hooked to a 101-key Enhanced keyboard. In truth, it was preset for machines with "extended BIOS ROM," regardless of what keyboard had been used. Until they discovered the error, they

were unable to utilize any multiple-key-press combinations.

Far and away the most common objection to the KB 101 Plus concerned its feel. Flynn commented, "There's something very peculiar about the way this keyboard sounds." Motor enthusiast Kane said, "While it is quite responsive in terms of its touch, its feel is like a car piston traveling up and down in its cylinder without the benefit of lubrication." Fully half of our panel described the feel as "mushy." However, as a testament to the subjectivity of these ratings, Brown independently claimed that the KB 101 Plus was "not mushy," and Bill Howard said it was "stiff and springy."

**Nobody accused the
Key Tronic KB 101 Plus
of being flimsy or poorly
made. Then again,
nobody thought it was
cheap either.**

With all that nit-picking out of the way most found at least one or two nice things to say about the keyboard. The idea of an optional nameplate or company logo plate appealed to the egotist in every one of us. Virtually every respondent remarked on it almost all agreed that it is an aesthetic advantage. Howard saw another angle: "The cutout for a logo . . . may strike some as affected; corporations will love it."

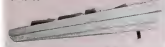
As for layout, critics of the KB 101 Plus were scattered and only mildly ruffled. Betts and Flynn disliked the placement of the Backslash key (on the bottom row near the right corner), but Losee and Brown thought it an improvement worth mentioning. Many raved about the 50-page manual; others thought it excessive for a mere keyboard.

Nobody accused the Key Tronic KB 101 Plus of being flimsy or poorly made. Then again, nobody thought it was cheap either. Ignoring the negative impressions made by the mushy feel (because of the availability of the upgrade kit), the consensus here would be that you get what you pay for in this case. Now all you have to do is decide how "deluxe" a keyboard you really want.



Key Tronic

With just two exceptions, the layout of the Key Tronic KB 101 Plus's colorfully labeled keys follows the IBM Enhanced standard. Instead of being located above the Enter key and below the Backspace, the Backslash is below the enlarged Enter and to the right of the Right Shift key, which is smaller. The Ctrl and CapsLock key locations can be switched.



to its left rear side. A rubber-footed 0.63-inch leg snaps down on each side of the back of the keyboard to raise the back and keep it steady, but there are no rubber feet under the front of the board.

The KB 101 Plus has a three-year warranty and comes with options galore. Besides the User's Guide, the keyboard comes with a Parts, Accessories, and Support Guide that advertises many of the company's other products—all related to computers, if not to keyboards—including Dvorak keyboard kits, keyboard cradles and covers, and a wide variety of tem-

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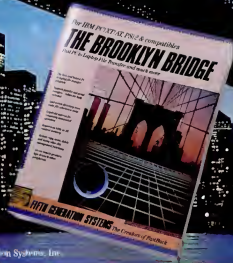
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NORTHGATE COMPUTER SYSTEMS

Northgate Omnikey Plus

Of the replacement keyboards we tested, Northgate's is the largest and heaviest. The \$119 board is also the most innovative, at least in terms of its developers' courage in deviating from IBM's standard layout.

The Omnikey Plus's unique features begin with its 107-key count. Four of the extra six keys are in its expanded middle cursor keypad, the most interesting one being the Omni key in its center. The other two extra keys are an Equals key in the numeric keypad and an extra Asterisk key below the Enter key.

The Northgate Omnikey Plus is the widest keyboard we tested—too wide for some sliding trays.

The next innovation of merit is the function key location: In the default configuration, 12 of the keyboard's 15 function keys are on the left. The first ten are in the same arrangement as they were on the first IBM PC-XT and AT keyboards. Function keys 11 and 12 are separate, just above the first ten, while 13 through 15 are located right of the lock indicator lights.

If you prefer to have all your function keys down the top, you can buy a \$25 up-

grade option from Northgate to get another set of 12. You can simply enable that new set, or you can "program" either of the two sets to serve as alternative function keys—so that they perform the functions you get from pressing the function keys plus Ctrl or Alt, for example. Though they weren't functional when we reviewed it, in the newest version of the Omnikey, two of

the three extra function keys serve special functions: F13 serves as a toggled coma/period lock; F14 allows you to change the keyboard's rates of repeat (the speed at which a character is redisplayed when it is held down) and delay (the length of the pause that occurs before a key starts to repeat); and F15 still isn't used.

Besides containing the mysterious Omni key (which according to the manual is used "to enter the same keystroke en-

Based on PC Magazine's recent review, you may want to buy this entire system just to get the keyboard.



OUTSTANDING FEATURE The tested configurations (\$6,595 for the 16-MHz unit, \$7,895 for the 20-MHz model) each came with a Wang monitor, a VGA adapter using Tseng Labs VLSI chips, a hard disk (42MB in the 381, 68MB in the 382), and a keyboard.

The latter is perhaps the systems' strongest feature. Built by Honeywell for Wang, the keyboard follows the standard 101-key layout. Simply put, it has one of the nicest touches of any keyboard I have ever used, including IBM's PS/2 keyboard. It also has an internal key click that you can make louder or softer by using a keystroke combination.

Both computers turned in respectable, but not stellar, performance times on our benchmark tests, in part because neither offers hardware memory caching. Interleaved memory, however, does help boost performance a bit.

While the prices of the fully configured Wang 381 and Wang 382 won't win prizes as low-cost bargains, they are not unreasonable when compared with other top brands such as IBM, Compaq, Tandy, or AT&T. If you are looking for a solid machine that is built well and backed by a major manufacturer, either of these Wang models deserves consideration.

—Alfred Poor

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PC
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FACT FILE

Northgate Omnikey Plus
Northgate Computer Systems, 13705 First Ave.
North, Plymouth, MN 55441; (800) 526-2446,
(612) 553-0111.
List Price: \$119.

In Short: This is the only keyboard of the bunch to offer a layout significantly different from that of the IBM Enhanced model. The 107-key Omnikey Plus's ability to have its function keys either to the left or on top should make it quite interesting for many users.

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INPUT DEVICES

KEYBOARDS



Northgate

With 107 keys, the Northgate Omnikey Plus's default configuration puts 12 of its 15 function keys on the left, where they were on the first IBM PC-XT and AT keyboards. Function keys 11 and 12 are separate, as are the extra function keys, 13 through 15. Another row of function keys can be added across the top of the keyboard. Besides containing the mysterious Omni key, the extra cursor keypad has 14 rather than the "standard" 10 keys. The PrtScr, ScrollLock, and Pause keys have been moved down to this pad. The other two novelties are an Equals key in the numeric keypad and an extra Asterisk key below the Enter key.



tered by pressing the 5 on the numeric keypad when Num Lock is off"), the Omnikey Plus's extra cursor keypad has 14 rather than the "standard" 10 keys. Instead of using the now-common inverted T for cursor control keys, the Omnikey Plus's middle pad duplicates the cursor keys, PgUp, PgDn, Home, and End, as well as the Insert and Delete keys. The PrtScr key on this keypad (it and its companions, ScrollLock and Pause, have also been moved from their Enhanced locations) must be tapped twice to get it to dump the screen contents to the printer.

At 20.25 inches, the Northgate Omnikey Plus is the widest keyboard we tested—too wide for some sliding keyboard trays on the market. Two 0.88-inch legs fold down in the back underneath the keyboard to increase the keyboard angle, while two 2-inch-wide cross-hatched rub-

**The Omnikey Plus's
sturdy metal case
helps it to win the
heavyweight crown.**

ber feet near the bottom front keep it steady. It features the standard pencil ledge/template holder. As in most of these replacement models, mechanical key-switch technology triggers the Omnikey Plus's noisy, relatively stiff keys. The 2.5-ounce operating force required to trigger them is the highest of all we reviewed.

This keyboard's sturdy metal case helps it to win the heavyweight crown as well, at 4 pounds 10.5 ounces (it's still 13 percent lighter than an IBM Enhanced keyboard). Unlike its peers, it has an 84-inch cable that can be detached from the keyboard body. Two cables come with the unit, one for IBM PC-XT and AT machines and another for PS/2s. Although there are three ports on the board, both cables (which also serve to connect to Amstrad, ATT, and Tandy computers) plug into the port about 8 inches from the right rear corner of the keyboard. The function (or future function) of the other two ports, which appear slightly different, isn't mentioned. Also on the back with the cable connectors is a small button switch that performs a Ctrl-Alt-Del to reboot your computer.

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SIGNIFICANT OTHERS

by Bruce Brown

Trying to coordinate the simultaneous testing of more than four keyboards by a panel of ten already-busy reviewers would be a Herculean task. But that's not why these three models weren't included among our main review candidates. The lack of any consensus as to their popularity saved these keyboards from our merciless scrutiny. Nonetheless, they're all popular enough to merit your attention.

Turbo 101

If you're a fan of the IBM Enhanced layout but don't want to pay IBM prices for a replacement keyboard, DataDesk's Turbo 101 may be for you. At \$149.95, it is expensive compared to its reviewed peers but still \$50 less than a true-Blue model. (A Tandy 1000 version is available for \$169.95.)

The Turbo 101 is the only one of these keyboards to duplicate the Enhanced key layout exactly. Like all of these replacements, it's smaller and lighter than its IBM prototype; in fact, it's the smallest of the seven units we looked at. Its midrange 3-pound 9-ounce weight is not likely to slide around on your desk, however, thanks to the three half-inch-square rubber feet on its bottom front.

The Turbo 101's generous 100-inch cord (shorter than the Enhanced keyboard's cord, but longer than those of the other replacement models) should successfully reach most tower units. Attached to the middle of the keyboard's underside, the cable can be threaded through molded channels going both left and right; these channels exit about 3 inches from either end of the keyboard.

The DataDesk keyboard comes without documentation, which shouldn't provide too much of a problem since the unit has only four, well-labeled switches—giving you the option of configuring the computer for XT, AT, e-XT, or e-AT operation or letting it set itself automatically; PS/2 operation requires an optional adapter (\$7 including shipping).

The only problem we had in operat-

ing the Turbo 101 was that the PrtSc key wouldn't cause the screen to print unless the Shift key also was pressed. The unit uses the same mechanical key-switch technology that triggers a computer's recognition of most replacement keyboards, and its operation is anything but silent. The keys make a "thunky" sound when pressed, while the Spacebar makes a metallic clank. The keys require 2.3 ounces of pressure to record a keystroke, which is one of the higher figures among these units.

A standard clone keyboard after the fashion of the Maxi-Switch and Chicony models, the \$89 Zeos RS is average to low-average in almost every way, from its midrange price to its light weight.

In light of its relatively high price, the Turbo 101's two-year warranty and lack of options—such as the ability to swap the positions of the Ctrl and Caps-Lock keys—are somewhat surprising. And as a straight IBM clone, its failure to provide PS/2 compatibility automatically is unexpected.

Turbo 101.

DataDesk, 7651 Haskell Ave., Van Nuys, CA 91406; (800) 826-5398, (800) 592-9602 (in Calif.).

HiTek RT-101

Thanks to its reasonable price, comparatively substantial weight, and long warranty, NMB Technologies' HiTek RT-101 is an impressive clone keyboard.

Sporting the same slightly altered layout found on the Chicony and Maxi-Switch keyboards—with the enlarged Enter key, relocated Backslash, and shrunken Backspace—NMB's Thailand-made \$60 keyboard is slightly fancier than either because of its sculpted keys. It is also a bit smaller and a lot heavier. In fact, though it takes up less desktop real estate than any of its peers, the HiTek's 4-pound-4-ounce weight is closer to those of the feature-rich Key Tronic and Northgate models than to any of the cheaper clones. Like the latter two keyboards—as well as the Maxi-Switch—it comes with a generous three-year warranty.

Despite the HiTek's weight and the two .75- by .5-inch rubber tabs on its bottom front, with its legs extended it is more prone to moving on the desk than most other keyboards. (It's much less likely to slide about if you don't extend the legs, as two more rubber tabs are found on its back.)

The HiTek's operation is relatively silent, with no click. Like most of these keyboards, it uses mechanical key-switch technology. Its required operating force of 1.9 ounces gives it the second-lightest touch among the units reviewed; the key travel length is .14 inch.

The HiTek RT-101 is bundled with many of the 286 and 386 desktop machines we test at PC Labs. Its 84-inch cable is attached to the middle of its back. Much like the Turbo 101, the HiTek has molded channels that direct the cable to openings 4 inches from the back left and right sides.

The HiTek has but one switch on the bottom—to configure it for use with PCs and XTs or ATs. You have to reach in with a pen or small screwdriver to change the setting, but the switch is clearly labeled; this is important because there's no documentation with the keyboard. The HiTek doesn't work with PS/2s, and it offers no provision to switch the Ctrl and CapsLock keys or redefine any other keys.

If you like a quiet keyboard and the standard clone layout, the HiTek's features recommend it.

HiTek RT-101.

NMB Technologies, 9730 Independence Ave., Chatsworth, CA 91311; (800) 321-3536, (818) 341-3355.

Zeos RS

A standard clone keyboard after the fashion of the Maxi-Switch and Chicony models, Zeos International's \$89 Zeos RS is average to low-average in almost every way, from its midrange price to its very light weight.

The Zeos keyboard is manufactured by NTC Co. (Nan Tan Computer Co., a Taiwanese firm) and is found with many 286 and 386 desktop machines. It features the same clone layout found on the Chicony, Maxi-Switch, and HiTek keyboards.

A relatively small keyboard, the Zeos takes up just a tad more space on your desk than the Turbo 101. It weighs a low 3 pounds 1 ounce, and thanks to its half-inch-square rubber feet, it doesn't slide around much. It also feels sturdier than you'd expect, given its light weight.

The only functional problem we noticed in this keyboard was inconsistent functioning of the PrtSc key. Sometimes pressing it would return an asterisk on the screen; at other times the expected screen dump would take place.

Utilizing mechanical key-switch technology, the Zeos RS has a 2.2-ounce key tension, giving it a somewhat clicky and springy feel. Its cable is an average 84 inches. The unit comes with a clear hard-plastic cover and a pamphlet of documentation small enough to be taped to the bottom of the keyboard for technical reference. An optional PS/2 adapter can be purchased.

Although Zeos boasts of a one-day average turnaround time for repairs and offers a 30-day money-back guarantee, its one-year warranty for the Zeos RS is way below average. That lack puts this otherwise average keyboard at the bottom of the pack.

Zeos RS.

Zeos International, 530 5th Ave. NW, St. Paul, MN 55112; (800) 423-5891, (612) 633-4591.

The Omnikey Plus was quite new when we tested it, and the documentation was not in final form, but we've since received a copy. The 36-page user manual is pretty comprehensive, though not as good as the Key Tronic's manual. Among the many topics it treats is how to set the eight-switch panel on the back of the keyboard. Besides setting up the keyboard to work properly with the computer at hand, and telling the keyboard which function keys are being used, the DIP switches let you use your computer as a terminal on a Novell LAN, or swap the functions of the Ctrl and Caps-Lock keys. The Omnikey comes with a three-year warranty.

PANEL REACTIONS

Northgate has a reputation for designing almost anything its users request. If the Omnikey Plus, then, is the keyboard that many users request, this would seem to signify that acceptance of the IBM Enhanced layout is less widespread than Northgate competitors' designs would lead you to believe.

Six of our panelists liked the changes implemented in the Omnikey Plus, some rather enthusiastically. Even the four who generally disliked the modifications had a

Six of our ten panelists liked the changes implemented in the Omnikey Plus.

few good things to say. Our straw poll indicated that the Omnikey Plus won over more than its share of fans. Reviewers Antinori, Betts, Brown, Kane, and O'Brien said they would buy one for their personal use. Seven panelists said they would buy this product for their company.

The tactile and audio responses of this keyboard garnered strong responses, not all of them positive. Some described the response as clicky and loud. Poor, for example, thought it felt "metallic." Kane thought the "keys are not as well attached or as heavy as IBM's."

The other major group criticism revolved around the return of the function keys to the left side of the alphabetic key area. Many of us who learned to type on



EDITOR'S CHOICE

• Northgate Omnikey Plus

The consensus of the editors (as well as project leaders and free-lancers) involved in this project was that computer users ought to be given a choice as to which keyboard they use. And one of their options really should be Northgate's Omnikey Plus.

Northgate's extra-wide monster with its 107 oddly arranged keys wasn't the ideal keyboard for everyone on our panel. But as it is the only keyboard to provide an alternative to IBM's Enhanced layout—and the sole supporter of the left-sided function keys that many people feel so strongly about—the appeal of this heavy, solidly constructed unit is in the departure it offers.

The malleability of the Northgate Omnikey Plus only adds to its attractiveness. Instead of having its function keys in the left location, they can be placed along the top, or in both places. Its Ctrl and CapsLock keys can also be swapped. Speaking of flexibility, we have to commend the Key Tronic Professional Series KB 101 Plus for offering variable key tensions.

While Key Tronic's keyboard fared far better than its peers in our "Would you buy it for your business?" poll, winning one less than Northgate's eight yeses, it didn't score nearly as well on our weighted ratings. When our panelists were asked to rate these keyboards, as well as the ones bundled with Compaq and IBM machines, the Northgate Omnikey Plus garnered the most 4s by far, with the highest overall score.

The Northgate's wealth of mutable features are impressive, but if we had it our way, we'd be able to choose between keyboards that offer things like longer cables with plugs on both ends, mouse ports, and variable height adjustments, and LCD screens that display keyboard macros. In short, the choice of our editors is to be offered more choice.

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 - 4105 RAMpage Plus MicroChannel 512k 486. 419.
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 - 5788 HL-8Ps PostScript Laser Printer. call
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 - 3438 ☐ 1st Math (ages 4 to 8). 22.
 - 3439 ☐ 2nd Math (ages 7 to 16). 27.
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5119 2400 Baud External Modem	179.
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2339 Inboard 386/AT (req. inst. kit)	859.
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4266 Above Board Plus 512k	419.
4267 Above Board Plus I/O 512k	449.
5336 Above Board Plus 8 2 Meg	699.
5342 Above Board Plus 8 I/O 2 Meg	739.
4272 Above Board 2 Plus 512k	469.
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2369 80287-10 (for PS/2 Models 50 & 60)	229.
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6014 Beyond EMS Board for PS/2 Model 60 (1 Meg)	339.
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- 5085 Multisync 3-D Monitor 689.

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- 3102 2400 Baud External Modem 179.
- 5285 2400 Baud Ext. MNP Modem (Luv. 5) 209.
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4624 80 Meg Int. HD ST4096 (28 ms) . . . 619.

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original PC or XT keyboards were thrilled to have the function keys back home where they belong; others liked the idea but had already grown accustomed to their top position. Some, like Howard, were annoyed by the reappearance of this layout. He said simply, "Northgate is living in the past."

Panel opinion ran roughly 2 to 1 in favor of modifications such as the Asterisk key in the bottom row, the additional complete cursor control pad, the Reset button on the back of the case to perform a warm boot, and the double-clutch PntScr function. Even those who spoke against these and other innovations did so half-heartedly; many indicated that they didn't think they would actually use the new keys, if only because they were set in their ways.

Beyond the particular changes, this product drew strong feelings from several reviewers with its fundamental quality and functionality. "I was impressed by its innovative use of color [Esc and Ctrl keys are red, Shift keys green, and Alt keys blue] and its sturdy construction," said Betts. "Northgate's supplier provides what seems to be the best-built keyboard," said Howard. And Kane said, "The Omnikey Plus is the best of the four keyboards I looked at. It's the product IBM would have built if it had extended the original AT keyboard, my keyboard of choice." O'Brien agreed: "Northgate has mastered the layout that IBM lacked to complete the package."

With all of these raves, you might be tempted to call Northgate up and buy one today. But before you do something rash, bear in mind that reviewer Losee wouldn't take one if you gave it to her. She pointed out that it was incompatible with our PC MagNet cursor speedup utility; she prefers the function keys to be horizontal across the top of the board, and she likes to put her keyboard in her lap while she types.

The Omnikey Plus is certainly a high-quality, innovative product, and its mid-range price of \$119 seems reasonable. If you basically like the feel of "true blue" keyboards but are disappointed with their layout evolution and want more options, it's a product to consider. As Matzkin put it, "The key layout is the result of considerable thought and reflects a desire to give users the best possible tool."

Kellyn Betts is an associate editor of PC Magazine. Bruce Brown is a frequent contributor to PC Magazine and a computer consultant currently based in Simsbury, Connecticut.

ODDBALL KEYBOARDS



**"If a man does not keep
pace with his companions, perhaps it is because
he hears a different drummer."**

Or maybe he is just using the wrong keyboard.

by Alfred Poor

There are millions of us who sit down each day to pound away on a standard-issue 101-key keyboard. And for the majority, that's all we need. But for some of you reading this article, a standard 101-key keyboard is as out of place as high heels at a surfing party or cutoff shorts on Wall Street.

You need not suffer in silence. Speak up! What's your problem: no desk space for your mouse, an accounting program that won't add two numbers when you want, or maybe you need to accept credit cards? Hey, no problem!

There are literally dozens of different keyboards available for almost as many different specialized needs, environments, and applications. Some take only modest liberties with standard key arrangements, while others go so far as to approach the

borders of bizarreness.

One example is the famous Dvorak layout. The standard QWERTY configuration (named for the first six alphabetic keys at the upper-left corner) was originally devised to slow down typists. Early typewriters had a tendency to jam, especially when the operator reached high speeds. Modern technology has eliminated the jamming, and the Dvorak keyboard was designed for more-efficient key placement. But Dvorak is old hat, now. You can get keyboards with this arrangement from a variety of sources, and there are even public-domain and shareware programs that will remap your keyboard to give you a Dvorak layout. What are some of the more exotic possibilities?

Realizing that there is vast room for improvement in this arena, we decided to

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Tennessee	15.0	15.3	15.4
North Carolina	13.8	13.9	20.1
Alabama	10.2	10.3	20.7
Arkansas	25.4	25.7	16.2
Florida	42.3	43.1	27.1
Georgia	28.2	28.1	19.8
Illinois	35.1	37.2	24.5
Indiana	14.4	14.2	14.1
Michigan	22.1	13.4	12.3
Minnesota	28.1	16.3	27.5
Missouri	24.1	26.7	19.2
Nebraska	21.2	22.0	22.9

Year	1979	1980	1981
1979	0.07	1.10	0.00
1980	0.01	0.01	0.00
1981	0.00	0.00	0.00
1982	0.00	1.00	0.11
1983	0.00	0.00	0.00

INPUT DEVICES

ODDBALL KEYBOARDS

round up some of the more unusual characters in the keyboard market. We did not subject them to our more typical rigorous testing, but we did try some out. We were able to verify that they did work as advertised, as far as we could determine with a quick look.

Key Tronic is one of the largest and most famous makers of replacement keyboards, and it quite fittingly has one of the largest catalogs, which includes some rather unusual models.

The Key Tronic KB5153 does not have a numeric keypad at the right-hand edge. Instead, the \$249 keyboard has a 3.5-inch-square opening revealing a black plastic surface. This is a touch-pad that can function in any of four different modes. It can act like a cursor pad; move the stylus that comes with it (or your finger) across the surface from left to right, and the keyboard signals a series of Right Arrow key presses. In Function Key Mode, you can program different regions to execute different commands for different applications. You can define from 4 to 36 locations at a time, depending on whether you use a 2 by 2 or 6 by 6 matrix. The keyboard comes with sample functions and templates for DOS, Lotus 1-2-3, WordStar, and WordPerfect. Mouse Mode and Graphics Mode are similar. The Mouse Mode moves the cursor in response to the *relative* movement of the stylus, while the Graphics Mode is like a drawing tablet where the cursor follows the *absolute* position of the stylus on the pad.

This keyboard is actually pretty handy.

Key Tronic KB5153

Instead of a numeric keypad, the \$249 Key Tronic KB5153 has a 3.5-inch-square touch pad that can function in four different modes.



The pad is not quite as easy to control as a mouse in some applications, but it can work with everything from *Microsoft Windows* to *Ventura Publisher*. I discovered that I actually had more control than with a mouse for paint programs, but I suspect that this is most likely a matter of taste. I found the Function Key Mode less useful; while 36 commands may sound like a lot, the prepackaged ones are not always the ones you need. The 1-2-3 template was quite useful, however, and because you can easily program your own templates, you may find custom templates the most useful feature of all.

The Key Tronic VA 101 is of a totally different stripe—magnetic stripe, that is. Designed to work with the magnetically encoded strips that grace most modern credit cards and contain (among other details) your account number, the VA 101 has an outgrowth in the upper-right-hand corner that has a slot down the middle. Take a credit card and swipe it through the slot, and presto! your computer will read the data from the card just as if you had typed it in.

The VA 101 can also take a bar-code reader, which will automatically decode most popular bar-code formats, including 3 of 9, interleaved 2 of 5, Codabar, Code 11, and the ubiquitous UPC (Universal Product Code). The bar-code data is sent to your computer just as if you had typed it in by hand. The unit accepts a variety of wands and laser scanners, giving you even more options.

The VA 101 can be configured with either the bar-code (\$700) or the magnetic stripe reader (\$600) or both (\$900). All modes offer built-in intelligence that computes the internal check digits on the coded information and will not pass the results along unless the information checks out. The keyboard has a microprocessor handling this task, and you will find the processing delay is barely noticeable. Both Key Tronic keyboards, like the one we reviewed in detail, are available from Key Tronic Corp., P.O. Box 14687, Spokane, WA 99214-0787; (509) 928-8000.

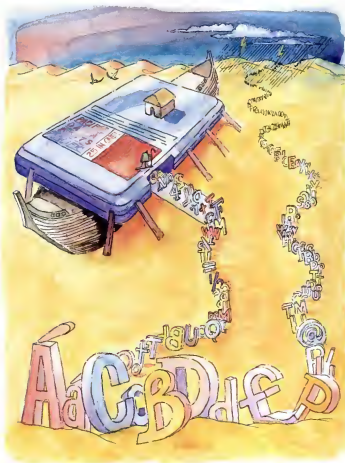
Jameco Electronics is one of a number of companies offering new keyboards that

Key Tronic VA 101

The \$700 Key Tronic VA 101 includes a magnetic stripe reader that "reads" credit cards. The keyboard is also sold with a bar-code reader (\$700), or you can get both (\$900).



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THE KEY TO ENABLING THE DISABLED

by Joseph J. Antinori

Some of the most innovative, most unusual keyboards and input devices in existence are special-purpose models for people with special needs—the handicapped. Nowhere is the PC's tremendous power for good more apparent than in the burgeoning field of assistive technologies.

While most of us can remember the feeling of liberation when we first put a PC to work, we cannot imagine the degree to which a disabled person can experience this phenomenon. For a blind person, a quadriplegic, or a victim of a debilitating disease, the PC can be a lifeline to independence, participation, and the satisfaction of accomplishment. Using electronic mail, for example, the disabled person can overcome the physical obstacles to meeting people and learning about activities and opportunities. Along the way, the feeling of isolation that often compounds the tragedy of disability lessens and sometimes just disappears.

The types of assistive input devices available are as various as the disabilities they are meant to circumvent. Companies like Furaltech Systems of North Liberty, Iowa; EKEG Electronics of Vancouver, British Columbia;

Polytel Computer Products of Tulsa, Oklahoma; and Koala Technologies of Santa Clara, California manufacture customized keyboards for those who have difficulty with the size or tension of the standard models. Ranging from regular keyboard layouts with enlarged keys and Braille keyboards to programmable membrane surfaces and single-switch entry systems that display a keyboard on-screen, solutions are available for almost every situation.

The EyeTyper, from Sentient Systems Technology of Pittsburgh, Pennsylvania, offers an alternative for the severely disabled user. A camera embedded in the keyboard enters keystrokes by determining where the user has trained his or her gaze. The user briefly focuses on a tiny light on the desired keycap, and it is entered.

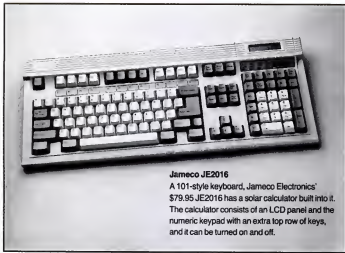
Words Plus of Sunnyvale, California, and Pointer Systems of Burlington, Vermont, offer custom systems that utilize a sensitive visor to understand input from a single brow or head movement; another Words Plus system can understand eyeblinks or eye movements using infrared scanning technology. Similar to the system used by renowned physicist Stephen Hawking, these products allow the user to select or

build words from software vocabulary menus. Add-on speech synthesis units like the Personal Reader (Kurzweil Computer Products, Cambridge, Massachusetts) and the Arkenstone Reader (Arkenstone, Santa Clara, California) pronounce the user's compositions.

Other technologies being pioneered by these firms are bound to benefit everyone someday. Voice recognition, for example, is a capability we all dream of employing on our PCs. The state of the art in voice recognition is currently exemplified by The Voice Connection of Irvine, California; Words Plus; and Interstate Voice Products of Orange, California. These companies' products that are being used by handicapped people have a recognition accuracy of up to 98 percent and vocabularies of up to 150 user-selectable words. The technology will improve.

For information about these products, or for help in building a customized solution, contact the IBM National Support Center for People with Disabilities at (800) 426-2133, or Apple Computer's Office of Special Education and Rehabilitation at (408) 996-1010. ■

Joseph J. Antinori is an editorial assistant at PC Magazine.



Jameco JE2016

A 101-style keyboard, Jameco Electronics' \$79.95 JE2016 has a solar calculator built into it. The calculator consists of an LCD panel and the numeric keypad with an extra top row of keys, and it can be turned on and off.

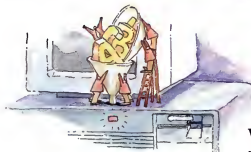
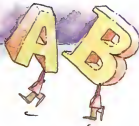
combine two common devices in a single housing. You may have given up on TSR calculators and other utilities because of the unexpected problems they cause as a result of conflicts with programs and a shortage of memory for large applications. Still, there are times when your checking account program won't add the two numbers you need to fill in a check amount, and a calculator sure would be handy. The \$79.95 Jameco JE2016 is a 101-key keyboard with a little LCD panel at its upper-right-hand corner and a solar cell between it and the numeric keypad. There is an extra top row of keys on the keypad as well. The LCD is for a solar calculator that you can turn on or off at any time, whether your computer is powered up or not. Hit a key, and the numeric keypad returns to its normal computer duties. You cannot "paste" the results of the calculator's computations into your application, but

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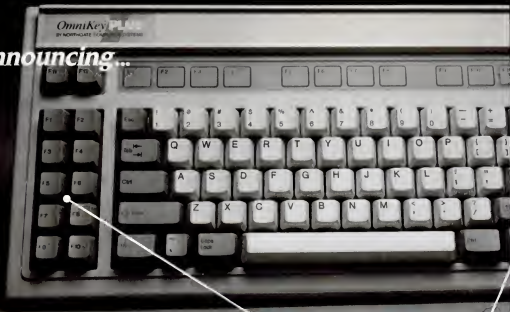
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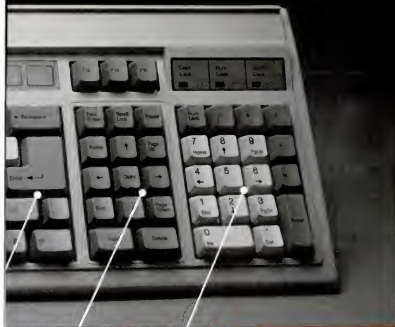
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Keycat

The \$99 Keycat from Amtac has a trackball mounted in its right side, but it still has room enough for separate numeric and cursor-control keys.



it's handy to figure some simple math when you are stuck in the middle of something else. You can contact Jameco Electronics at 1355 Shoreway Rd., Belmont, CA 94002; (415) 592-8097.

Perhaps you have a different problem. Maybe you suffer from a shortage of desktop real estate but use *Microsoft Windows* or some other mouse-loving application. You can get a separate trackball, which is like a mouse on its back, but it will still take up at least a little more space than just a keyboard. Or you can get a keyboard like the Keycat from Amtac. The \$99 keyboard has a trackball mounted in its right side yet still has room for separate numeric and

cursor-control keys. The Keycat is easy to connect, since the serial cable for the trackball is one with the regular keyboard connector. The keyboard comes with software so that the trackball emulates a Microsoft Mouse. The Keycat also solves a basic problem faced by most detached trackballs; it is hard to "click and drag" with a trackball because it is hard to hold down a button and roll a ball with the same hand. The Keycat has three "mouse" keys where the left hand can hold them down while your right does the rolling.

The Keycat worked great on a true-blue IBM PC-XT. I use several mouse-intensive programs and discovered that I prefer

the trackball to a mouse. It is easier to keep your hands on one device, and it is not hard to adjust to the separation of buttons and pointing device. Amtac's address is 43-72 10th Street, Long Island City, NY 11101; (718) 392-1703.

Or maybe you have more-specific needs. Does your PC live the schizophrenic life of a standalone computer and a terminal to a larger host? Do you have a pad of Post-its stuck to your work area reminding you what combination of keys to press when you want an F17 key? Fear not—you have not been forgotten.

For example, Key Tronic offers a \$229 122-key monster called the KB3270/PC, which, as you might suspect, is a PC replacement keyboard designed to work with 3270 terminal emulation packages,

The \$99 Keycat, from Amtac, has a trackball mounted in its right side yet has room for separate numeric and cursor-control keys.

KEA Systems

KEA Systems' \$289 replacement keyboard looks just like the Digital Equipment Corp. VT200 keyboard you use with VT220 terminals. The company also sells a model for use with VT240 terminals for \$435.



including AST, Attachmate, CXI, Forte, and Irma. On the other hand, if you prefer to deal from a full DEC, KEA Systems (2150 W. Broadway, #412, Vancouver, BC, Canada V6K 4L9; (800)663-8702) offers a replacement keyboard that looks just like a Digital Equipment Corp. VT200 keyboard as used with VT240 (\$435) or VT220 (\$289) terminals. Having all the correctly labeled keys makes it easier to work when connected to a host computer via terminal emulation. There are also an increasing number of VAX applications being ported to PCs as standalone applications, and this keyboard makes it possible for an operator to work at either a PC or a terminal without having to learn two different layouts.

The point of all this is quite simple: You need not suffer the 101 blues just because that keyboard came with your computer. Stand up, look around, and reach out. There are weird and wonderful keyboards, just waiting to help you. ■

Alfred Poor is a contributing editor of PC Magazine.

Peter Norton on Paul Mace:

"The *Mace Utilities* include a recovery program that attempts to recover as much data as possible from a hard disk that has been reformatted, and that hasn't been protected by a 'snapshot' utility. This is the *ultimate* recovery utility..."

—Peter Norton
The Hard Disk Companion, p. 338

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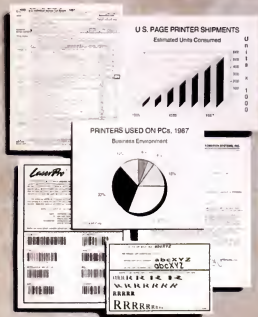
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Lab Notes

Is working at your PC hazardous to your health? At first sight that question may seem silly; no rivers or bays have been spoiled by PC data spills; no communities have been rendered uninhabitable by toxic memory dumps; no species have been endangered by the random killing of files. In short, although the manufacture of PCs involves environmentally sensitive chemicals and technologies, if any product can be regarded as safe to be around and use, the personal computer would be it.

Yet doubts persist. Clusters of miscarriages have been associated with computer use; headaches and eye problems have been attributed to working at terminals; and even the dread word *cancer* has been whispered by researchers as a potential computer-related health problem. Since the PC itself is hardly eight years old, questions about the effects of long-term use are impossible to answer definitively. And studies to date can be cited that provide reassurances of safety and point to potential problems with PCs and other electrical devices.

The possible PC hazards stem not from toxic chemicals, but from a potential nemesis more insidious and invisible: electromagnetic radiation, or EMR. EMR possesses the qualities of the perfect poison in an Agatha Christie novel: it is colorless, odorless, tasteless, and after it does its deadly work, it vanishes without a trace.

Figure 1 shows the spectrum of electromagnetic radiation—not all of which is bad. Sunlight is one form of EMR and is vital to life itself. Moreover, the infrared rays that warm your toast, the microwaves that cook your lunch, the radio and TV signals you tune in every day, and the X rays that help diagnose ailments are all examples of beneficial electromagnetic radiation.

At a high enough exposure level, however, all forms of EMR are dangerous. X rays are known to cause cancer, and last summer's media campaign for sunscreens alerted everyone to the dangers of ultraviolet radiation. Infrared radiation can burn or

The Big Question: Is the PC Environment A Safe Place to Work?

■ Measurements made in PC Labs help put some of the conflicting scientific evidence in perspective so you can make up your own mind about this complex issue.

even sear flesh. Microwaves can cook living creatures from the inside out and have been implicated in causing cataracts. Even lower-frequency radio waves have the potential for roasting you and have recently been found to cause more subtle biological changes—possibly even cancer.

At some point, then, beneficial forms of electromagnetic radiation cross the line and become health hazards. When it comes to computer safety, the question is where PCs and video display terminals (VDTs) fit in the continuum from good to bad. Any equipment that generates EMR has the potential for causing health problems. Does personal computer equipment pose such hazards?

To help you answer this question for yourself, in preparing this PC Lab Notes, we not only surveyed much of the available literature on the subject, but also enlisted PC Labs and a number of outside experts. We conducted extensive tests, making actual measurements of suspect emanations from a number of monitors and computer systems.

Anecdotal evidence is easy to find but impossible to assess. Anyone who gets a

headache after a long day at the office can blame his or her PC, and no one can prove him or her wrong. And since the history of the PC's use in the office is so short, the fact that no suspiciously large number of its millions of users have mysteriously passed away on the job can't clear it of suspicion.

Moreover, all the potential hazards of PC use may still not be known or even suspected. Supposedly benign technologies and products often prove to have unexpected and dire side effects long after they have become accepted in commerce and everyday life. It took more than four decades before the dangers of asbestos in building materials became widely known, and effective regulations on it were slow in coming. Civilizations have risen and ebbed, all the while being ravaged by deadly toxins of their own making, because they did not understand the mechanisms through which the problems were caused. The lead pipes that carried much of the Roman water supply are a case in point. The possible health effects of extremely low frequency radiation—a part of the electromagnetic spectrum that is emitted by PCs—are today as unknown and mysterious to the public as were the toxic properties of lead plumbing two millennia ago.

Fortunately, we can justifiably add the more than 30 years of experience gained with computer VDTs to our knowledge base for PC health effects. PCs and VDTs share the same technologies. Both rely primarily on cathode-ray tubes in monitors for displaying information, for example. Since both technologies use signals of ap-

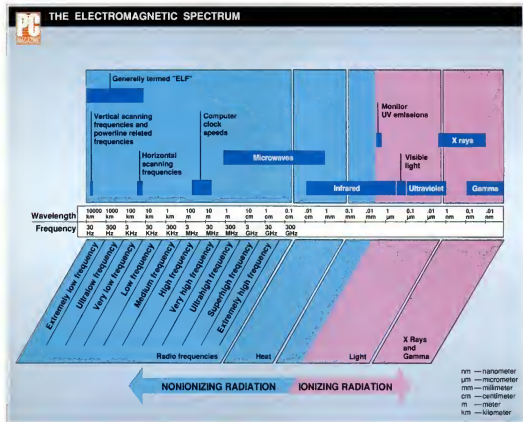


Figure 1: Electromagnetic radiation (EMR), energy that moves through space at various frequencies, is divided between high-frequency ionizing radiation and lower-frequency non-ionizing radiation.

proximately the same frequencies, they generate many of the same EMR components. The essential difference is that PCs add a box containing high-frequency (strictly defined, signals in the range from 3 to 30 MHz) data processing circuitry on your desktop; with VDTs, the principal high-frequency electronics are remotely located.

Even adding our experience with VDTs is of limited value, however, for despite decades of research, no consensus on the safety of VDTs (and thus, personal computers) has emerged. The conflicting results of studies have lined up two opposing parties, each of which is unlikely to be swayed by the arguments of the other. On

one side are the makers of electronic equipment and the organizations that employ the people who use it. This group believes the equipment is safe. On the other side, many of the people who actually work at VDTs and personal computers all day long have their doubts. It's the classic employer-employee struggle with a technological twist.

The employee viewpoint, however, is buttressed by a variety of studies that show biological effects of electromagnetic radiation and an association between VDT use and health problems. The most notable of these problems is the alleged increased risk of miscarriage. For example, a 1988 study by M. K. Goldhaber, M. R. Polen, and

R. A. Haitt of 1,583 pregnant women in northern California showed that those who used VDTs for more than 20 hours per week had a significantly higher incidence of miscarriage.

On the other hand, VDT makers and employers rally a whole range of other studies (many of which they have funded) that have failed to find any such risk. At a conference on VDT safety in Montreal in September 1989, a University of Toronto study of 800 pregnant mice subjected to electromagnetic fields of the kind given off by VDTs suggested that there's no relationship between spontaneous abortion and VDT electromagnetic fields.

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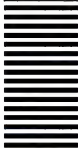
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Reason #8

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Requested Line of Credit \$ _____

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Present Address Street _____ Apt. # _____ City _____ State _____ Zip _____

Social Security Number _____ Home Phone _____

Date of Residence _____ Monthly Payment \$ _____ ☐ Buy ☐ Rent ☐ Other _____

Previous Address _____

Date of Residence _____ From _____ To _____

Your Employer (If self-employed, see near panel.) _____

Date of Employment Mo. _____ Yr. _____ Position _____

Monthly Income Gross \$ _____ Net \$ _____

Employer's Address Street _____

City _____ State _____ Zip _____ Business Phone _____

Previous Employer _____ Address _____

Date of Employment _____ From _____ To _____

Other Income _____ I have received since (Date) _____

Income from alimony, child support or separate maintenance payments need not be disclosed if you do not wish to have it considered as a basis for repaying this obligation.

Monthly Income Gross \$ _____ Net \$ _____

Name and Address of Nearest Relative Not Living With You _____

Relationship _____

b. Credit Information

Include joint information, if joint account requested.

Bank Account Bank Name _____ ☐ Checking ☐ Savings _____

Address _____

Bank Account Bank Name _____ ☐ Checking ☐ Savings _____

Address _____

Bank Loan Reference Bank Name _____ Address _____

Payment _____ Balance _____

Bank Card Reference Bank Name _____ Address _____

☐ VISA ☐ Mastercard Payment _____ Balance _____

(please check appropriate box):

☐ **Joint Credit** with another person. Complete all information.

☐ **Individual Credit** but rely on income or assets of another person as a basis for repaying the credit requested. Complete all information

☐ **Individual Credit** Complete sections "a" and "b" only.

Please complete all appropriate sections, providing at least two years' residence and employment history. This will enable your information to be processed as quickly as possible. If you are self-employed, please be sure to complete section "d" below.

Other Credit Card Reference Bank Name _____ Address _____

Payment _____ Balance _____

Other Credit Reference Bank Name _____ Address _____

Payment _____ Balance _____

Account No. _____ Expires _____

Driver's License No. _____ State _____ Expires _____

c. Joint Personal Information

Joint Name First _____ Initial _____ Last _____

Date of Birth Mo. Day Yr. _____ Social Security Number _____

Address Street _____ Apt. # _____

City _____ State _____ Zip _____

Date of Residence Mo. Yr. _____ Home Phone (_____) _____

Employer _____

Date of Employment Mo. Yr. _____ Position _____

Monthly Income Gross \$ _____ Net \$ _____

Employer's Address Street _____

City _____ State _____ Zip _____ Business Phone _____

City _____ State _____ Zip _____ Business Phone _____

City _____ State _____ Zip _____ Business Phone _____

City _____ State _____ Zip _____ Business Phone _____

City _____ State _____ Zip _____ Business Phone _____

City _____ State _____ Zip _____ Business Phone _____

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City _____ State _____ Zip _____ Business Phone _____

City _____ State _____ Zip _____ Business Phone _____

d. Self-Employed Information

Complete this section only if you are self employed.

Business Name _____

Business Address _____

☐ Proprietorship ☐ Corporation ☐ Partnership Business Phone (_____) _____

Description of Business _____

Your Position _____ In Business Since _____

Your annual income from business _____ Business' annual income (gross) (net) _____

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(_____) Telephone _____ Personal Banker's Name _____

2. Accountant's Name _____

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3. Financial statement on business attached. _____

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a pregnant mouse, pregnant human workers may not be reassured. And that's the problem. As in any scientific discipline, the VDT studies are subject to interpretation. Moreover, the human VDT studies are correlational rather than causal—they can *associate* a problem with VDT use but *cannot prove* a true cause-and-effect relationship. The EMR from the computer terminals could be causing miscarriages, or something else about the terminals or the way a particular study was conducted could have influenced its results. For example, the 1988 California study cited above includes an admission that its results may have been confounded by unmeasured workplace factors such as poor ergonomics and job-related stress.

Stress rather than radiation is, in fact, a prime contender for the cause of health effects associated with VDT use. At the same Montreal conference noted above, Rosalind Bramwell of the University of Manchester presented a study of nearly 4,000 female workers in Britain that indicated that increased stress among VDT users leads to an increase in the number of menstrual problems.

On the other hand, a growing number of studies have found cause-and-effect relationships between EMR and biological changes in tissues grown under laboratory conditions. Some of the effects occurred when the tissues were subjected to electromagnetic fields of the same nature as those created by personal computers and VDTs.

The contradictions between the various studies may well give you the feeling of having both feet firmly planted in midair. While PC Labs can't get into embryological and epidemiological research, we did carefully measure the various electromagnetic emissions from personal computer equipment, which should help you put the various possible EMR risks in perspective. We've correlated these measured values with the values that have been found hazardous in scientific studies. Although no claim can be made as to whether PCs are dangerous or safe, based on the PC Lab's findings, you'll at least know what your worries may be and what you can do about them.

EXAMINING X RAYS

X-radiation is perhaps the most publicized danger connected with equipment based

on cathode-ray tube (CRT) technology. CRTs include television picture tubes, oscilloscopes, radar screens, and computer monitors. Many early color television sets did indeed emit prodigious amounts of x-radiation, and the similarity between a color TV screen and a color computer monitor is all too obvious.

The mechanism by which X rays cause cancer is well understood. X rays are a form of ionizing radiation. That is to say,

the photons that make up the X-ray signal contain sufficient energy to break up the chemical bonds in molecules—including those of the DNA in chromosomes. Once the DNA in a cell has been changed, the genetic code of the cell is altered. The cell may die immediately, or it may just subtly change its activity. When a mutant (altered) cell replicates, however, the changes in it are passed on to its progeny. If these changes affect the growth control



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mechanism of the cell, it and its offspring may multiply rapidly and uncontrollably as cancer.

The chances that any one cell will react to X rays in such a way to cause cancer are minuscule. However, given enough rays reacting with a sufficient number of cells, the cancer potential becomes real and worrisome.

The concern that ultimately caused the federal government to issue strict regulations on the x-radiation emitted by television sets (and computer terminals) had a very real basis. Certain television sets in the early 1960s emitted X rays of such strength, you could make a radiograph of the bones in your hand using the television set as an X-ray source!

How did they do it? One of the many ways that X rays can be produced is through a rapid deceleration of electrons. When the electrons slow down they must give up energy and (depending on their momentum) some of this energy is emitted as X rays.

Early television sets used a vacuum-tube high-voltage rectifier to generate the current that drives the electron beam in the display tube and a similar tube, the shunt regulator, to maintain a constant voltage on the screen. These tubes were themselves essentially miniature X ray generators: they functioned by passing a huge electron flux from the tube's cathode to its anode, where the electrons were rapidly decelerated. X rays were emitted in the process.

Not all television sets even of that early vintage were so dangerous, however. In fact, the culprit proved to be defectively manufactured shunt-regulator tubes, which did not properly shield their anodes. The result was the emission of a concentrated, pencil-like beam of X rays through the bottom of the television set. Unless you had the television resting on your stomach—unlikely in those days of hundred-pound monster TVs—you would have been safe from its effects.

Moreover, vacuum-tube high-voltage rectifiers and shunt regulators have long been obsolete. They've been replaced by solid-state silicon diodes that emit no x-radiation. (Electrons go through no rapid deceleration in silicon diodes.) Since no known PC monitor uses vacuum tube rectifiers, the x-radiation problem in PCs

from that source is nonexistent.

However, all CRT-based devices do have another potential source of X-ray emissions. Every CRT creates its image by shooting a ray of electrons at the phosphors that coat the inner face of the screen. When they strike the phosphors, these electrons decelerate rapidly. Most of the energy from the electron beam goes to excite the phosphors, which in turn emit the visible light of the image. Some of it, however, can generate X rays, and the higher the voltage inside the tube, the larger the X ray flux. Color tubes, which operate at poten-

**The CRT tube is
crafted from several
varieties of glass that
block soft
X-ray emissions.**

tials as high as 30 kilovolts, produce thousands of times more x-radiation than do monochrome tubes, which operate below 20 kilovolts. (X-ray emissions increase by about a factor of ten for every one kilovolt increase.)

ARE THESE X RAYS DANGEROUS?

Probably not. X rays are classified into two types. Low-energy, or soft X rays, have wavelengths from 0.01 to 1 nanometer (a nanometer is a length of one billionth of a meter), and have little penetrating power. High-energy, or hard X rays, have wavelengths shorter than 0.1 nanometer, and can pass through and interact with the human body. Medical X rays are hard, and because hard X rays can cause cell damage, the government has placed strict limits on exposure to them.

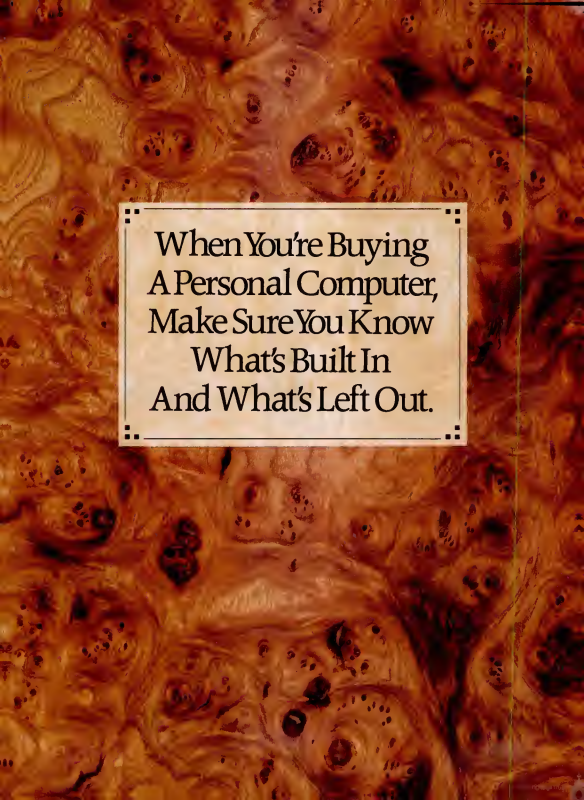
The electrons in the beam of a CRT have little energy and can produce only soft X rays. This radiation is effectively absorbed by the glass of the CRT. Although a CRT looks relatively simple—hardly more than an oddly shaped glass bottle with some metal pins sticking out its narrow end—it's actually a very complex creation. Indeed, the CRT is believed to be the most complicated consumer product made before the advent of the microprocessor. Rather than one uniform kind of

glass, the tube is crafted from several varieties, each tailored to a specific purpose. The wide face of the tube is thick—sometimes as much as one-half inch. It's made from glasses rich in strontium and lead, which block the soft X-ray emissions and keep them within the tube.

Regulations promulgated by the Food and Drug Administration set a maximum limit on X-ray emissions from television sets and terminals alike of .5 milliroentgens per hour, measured at a distance of 5 centimeters from the screen. That's about 2 inches, which would be very close watching indeed. Devices with greater emissions are not permitted to be sold in this country. Moreover, the measurement of x-radiation under this standard must be made under worst-case conditions. Not only must all controls on a television set or terminal being tested be advanced to the position that maximizes x-radiation (settings at which the set is unlikely to be operated), but also failure conditions that would result in the worst possible X ray emissions must be simulated. (For example, one must check the effect of the failure of a voltage regulator, which would increase the potential of the CRT electron beam. The simulation conditions often result in the catastrophic failure of the equipment during the test.)

Compliance testing by the FDA has found cases of excessive X-ray emissions from computer terminals. For example, a 1981 study found that roughly one out of 12 VDTs evaluated emitted x-radiation above the 0.5-milliroentgen-per-hour ceiling. The problems were confined to 8 units out of 91 and represented three different models. These out-of-compliance models were either recalled to be modified to comply with the emissions requirements or were not permitted to be sold on the U.S. market.

To find out where PC equipment stands today, PC Labs measured the X-ray emissions of several popular computer monitors, including an IBM monochrome display, the IBM Color Display (CGA), the IBM Enhanced Color Display (EGA), the IBM Model 8503 monochrome VGA display, the IBM Model 8513 color VGA display, the Compaq VGA display, and three NEC MultiSync models (II, 2A, and 3D). The X-ray emission measurements were made in PC Labs by a certified health physicist. During testing, the monitor screens were fully illuminated, with all controls advanced to their maximum positions. The measurements were made at the



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specified distance of 5 centimeters from the screen. Under these conditions, the measurements are believed to represent worst-case X-ray emissions in normal operation of the equipment. (We did not simulate the abnormal conditions induced by component failures. However, this normally is required for full FDA-compliance testing.)

The results of our tests revealed no measurable x-radiation from any of the displays. In that the threshold limit for detection of the equipment used (the same equipment specified by the FDA regulations) was .2 milliroentgens per hour, X-ray emissions from this equipment was at least two and a half times lower than the federal guidelines.

These measurements suggest that any fears you have about x-radiation from your computer monitor are unfounded.

UNDERSTANDING ULTRAVIOLET

Ultraviolet radiation is part of sunlight—a growing part, thanks to the diminishing ozone layer in the stratosphere. Its name describes it—ultraviolet is the invisible component of sunlight beyond the violet end of the spectrum. It has shorter wavelengths (180 to 400 nanometers) and higher frequencies than visible light. Physically, that means that ultraviolet photons are more energetic than those of visible light. In fact, the ultraviolet spectrum spans the transition range between ionizing and non-ionizing radiation. UV photons can be energetic enough to cause chromosomal damage, and UV has been implicated in causing cancer. Ultraviolet radiation also triggers the skin's protective tanning reaction and can burn the skin, as every sunbather knows.

Unlike X rays, however, ultraviolet rays are not penetrating. The thick atmospheric blanket of ozone stops them quite well; a thick blanket of cotton—or even a thin shirt—does quite a good job. Consequently, the effects of ultraviolet on the human body are limited to the places that sunlight can reach: the skin and the eyes. Today, it is generally agreed that exposure to ultraviolet radiation can cause skin cancers, cataracts, conjunctivitis (irritation of the lining of the eye), keratitis (inflammation of the cornea), pain, and light intolerance.

Moreover, current evidence indicates

that UV exposure is cumulative. That is, the longer you bathe in its rays over your lifetime and the stronger the rays, the greater the chances of unfavorable consequences. It is also believed that exposure early in life has a greater effect than later exposure.

All computer monitors emit some UV along with the visible light of their images. However, the most energetic—and thus the most dangerous—UV wavelengths cannot escape the CRT. Ordinary glass strongly absorbs ultraviolet radiation with wavelengths shorter than about 350 nanometers. The only part of the UV spectrum that may be present in CRT emissions is in the range of 350 to 400 nanometers. (Some sources list the beginning of UV radiation at 380 nanometers.)

To determine whether UV emissions of computer monitors might pose any potential health hazard, the same computer displays used to test x-radiation were measured for UV output. These tests were conducted by Hoffman Engineering Corp., an independent contractor experienced in spectral measurements, under the

supervision of PC Labs. All emissions from 350 to 780 nanometers (at intervals of 5 nanometers) were measured, again with all monitor controls at their maximum setting and the screen fully lit.

The results showed that some ultraviolet emissions were generated by all of the displays tested. The emission level declined with decreasing wavelength and was virtually absent in most cases at wavelengths shorter than our 350-nanometer test limit. The worst emissions came from the IBM 8503 monochrome VGA display; the spectra of all color displays were so similar as to imply that they all used the same phosphors—perhaps even the same CRTs. In all cases, however, ultraviolet emissions were far lower than emissions in the visible light spectrum. Typically, UV emissions were no more than 5 percent of the level of the maximum emissions in the visible band.

To put these measurements in perspective, Figure 2 compares the results of selected screen displays with the measurements of a "deluxe cool white" fluorescent tube—the kind often used in

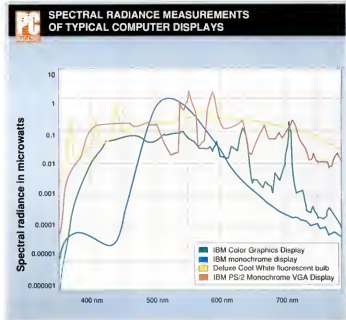


Figure 2: All CRTs emit ultraviolet radiation. Of the popular displays, the original IBM green-screen monochrome display emits the least; the white-screen VGA monochrome display emits the most. Nearly all color displays have the same emissions spectra. However, in comparison with a deluxe cool white fluorescent bulb, UV emissions from monitors are small.

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office lighting. Its UV emissions measured about 20 percent of its maximum visible-spectrum emissions. Based on typical monitor brightness levels and on office lighting levels mandated by OSHA, CRT emissions of ultraviolet radiation would be a fraction (in the range of one-quarter) of the level reflected from a white sheet of paper on a desktop when the monitor is operated under the test conditions (brightness and contrast advanced fully, screen fully lit). In normal operation, ultraviolet emissions from a monitor would be substantially less.

From these measurements, the modest ultraviolet emissions of computer monitors would appear to be safe. If UV in the range 350 to 400 nanometers is hazardous, office fluorescent lighting likely represents many times the danger presented by the typical computer monitor.

THE MICROWAVE MENACE

Microwave energy—which cooks food in microwave ovens and blasts radar beams over the horizon—has well-documented effects on living cells. A potato or a poodle in the microwave oven will both cook, and the mechanism is well understood. The microwave signal excites water and fat molecules, transferring its energy to them as thermal energy (heat). Food is cooked by microwaves because the heat induced in the food accumulates faster than it radiates away, raising the temperature. Cell proteins break down as temperature increases. Cells die. The food is cooked.

Microwaves penetrate moderate distances through living tissue. Consequently, organs inside a body can be heated (potentially killed) by microwave beams. The thermal energy of microwaves is also known to cause cataracts.

Wavelengths longer than microwaves (those typical of VHF television, FM, and standard broadcast radio signals, for example) can also produce thermal effects by transferring energy to materials. These longer wavelengths, however, are less reactive with biological tissue; they tend to penetrate without being absorbed.

Aside from thermal effects, microwave and other radiation in the radio spectrum (that is, higher in frequency than about 30 kHz) is not thought to pose health hazards. While some studies have implicated microwaves in causing cataracts, most of

these have been at intensities that cause thermal effects. (Cataracts caused by non-thermal microwaves have been reported, although the preponderance of studies have found the contrary.)

Microwave and other radio-frequency heating requires very strong signals. Microwave ovens operate at levels of hundreds of watts. For this reason, PC Labs did not measure emissions in the microwave or radio frequency spectrum. All computer equipment must already be certified to abide by subpart B (formerly subpart J) of part 15 of the Federal Communications Commission rules and regulations. These regulations set interference standards that are orders of magnitude below the radiation levels necessary to achieve thermal effects. The health standards deal in volts per meter, whereas the FCC interference standards limit emissions to microvolts per meter.

Moreover, PCs do not directly create microwave energy. Although microwaves are theoretically created as harmonics of the signals generated inside the computer, the level of such harmonically created microwave signals is essentially unmeasurable.

It is possible that there are nonthermal microwave effects that may be active at lower signal levels. If these effects are real, they are believed to be a result of low-frequency modulation of the microwaves. Such modulation effects would be similar to the effects of direct radiation at such lower frequencies, as discussed below.

DANGEROUS ELVES

At the very bottom of the electromagnetic spectrum is extremely low frequency radiation. Technically, ELF (as I'll abbreviate extremely low frequency hereafter) comprises the frequency range from 30 hertz to 300 Hz. In common usage, however, the term is extended to include any frequency below 30,000Hz, and so includes the 20 to 20,000-Hz frequency range of your stereo system. As are all frequencies below 450 kHz (450,000 Hz), ELF is ignored in the FCC certification process. ELF has long been thought innocuous, but a number of recent newspaper and magazine articles have raised doubts about its safety.

Strictly speaking, the ELF of concern is not radiation but captive electric and magnetic fields that are generated by strong electric currents in power systems, appliances, and other electrical equipment (including computers and their peripherals). The two types of fields—electrical and

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CPU speed	Excellent	Excellent
Expandability	Excellent	Excellent
Hardware compatibility	Excellent	Excellent
Documentation	Excellent	Good
Technical support	Very Good	Unacceptable
Value	Good	Satisfactory
Final Scores	8.5	7.1

Source: InfoWorld, July 24, 1989

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magnetic—are related and arise from the same phenomena, but they have individual distinguishing characteristics. Electric fields generate a potential (a voltage), are measured in millivolts or volts per meter, and are relatively easy to shield against by using conductive materials. (The wire braiding shields the center conductor from electric fields in coaxial cable, for example.) Magnetic fields generate a current (amperage). These fields are measured in milliamps per meter or sometimes in related units of gauss, and are difficult to shield against.

A number of recent studies have correlated the strong ELF fields associated with power lines and electrical distribution systems with increased cancer risk. Electric blankets and water bed heaters have also been implicated. The photo on the left in Figure 3 shows pulsed ELF waveforms generated by computer equipment—the same kind that has demonstrated biological effects in the laboratory. These effects include changes in cell membrane permeability, altered prenatal development, and the promotion of the growth of cancerous cells.

ELF research to date has been of two types: laboratory studies made on cell cultures and animal tissues; and epidemiological studies—that is, research that attempts to find a common link between the backgrounds of sick people.

The epidemiological studies of power distribution systems have mostly correlated illnesses with the exposure to ELF fields. The results of these studies to date have been mixed. The most recent, however, have been aimed at answering the criticisms made of earlier studies that had found a positive correlation between childhood cancers and conditions in which large ELF fields are present. (The fields themselves were not measured.) In the United States and Sweden, correlations between cancer and strong ELF fields associated with electrical distribution systems have been found, although contradictory studies have also been published.

In the laboratory, the potential biological effects of ELF at levels below those that would cause tissue to be heated have been extensively investigated for about the last decade. The results of that research are beginning to show that far from being innocuous and noninteractive with biological tissue, ELF electrical and magnetic fields can be subtly active—with both beneficial and harmful effects.

On the positive side, ELF fields are used in treating bone fractures; the fields apparently promote bone growth and hasten healing. On the downside, ELF fields also appear to promote the growth of cancerous cells. ELF fields have had demonstrated effects on the calcium channel permeability of cell membranes. This can affect a variety of cell functions, including the transmission of electrical signals in nerve tissue. Again, ELF fields have been shown to affect protein synthesis and alter

circadian rhythms. Research has also shown that developing nervous systems may be particularly susceptible to ELF fields, and that these effects may be latent, showing up only in specific situations or at later times.

Not all of these dire reports have stood up to scrutiny, however. Attempts to replicate the results of some of the studies have failed. And, of course, since these lab studies were carried out *in vitro*, there is no guarantee that the effects on human beings would be identical. Nonetheless, a consensus is emerging that ELF fields can be biologically active at levels lower than were once thought possible.

One of the things discovered about ELF fields is that they do not behave like ionizing radiation. The fields are not energetic enough at the molecular level to change or destroy the chemical bonds in cells; thus, they don't damage chromosomes. Instead, the ELF fields seem to mimic the electrical changes that normally occur in living cells in the body. By changing the calcium permeability of cells, for example, they can change the response of a nerve cell to stimulation.

This mimicking of normal cellular processes may be at the root of the cancer-promoting potential of ELF. Some scientists have noted that the membrane sites at which some ELF reactions occur appear to behave as receptors for cancer-promoting chemicals. ELF fields also appear to increase the chemical activity of a compound that is known as ornithine decarboxylase, and this effect has been associated with

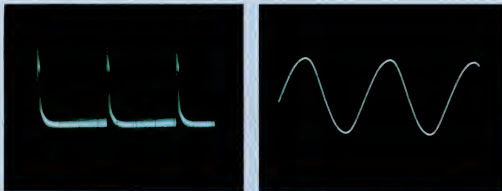


Figure 3: In some studies, pulsed ELF waveforms, similar to those created by the vertical sync signal of computer monitors such as those of the NEC MultiSync monitor (left), were shown to be more biologically active than the sinusoidal waves created by the magnetic fields generated by power distribution equipment (right).

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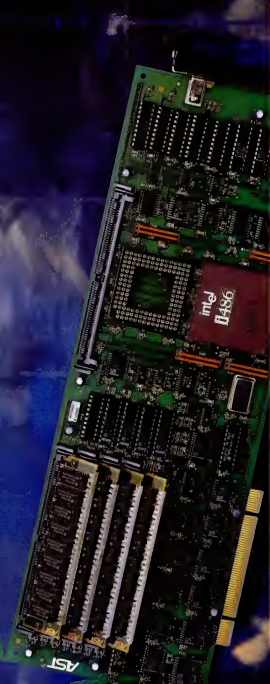
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CIRCLE 536 ON READER SERVICE CARD

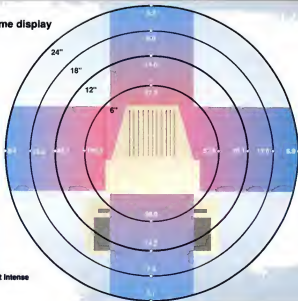




THE ELF FIELDS OF TWO POPULAR DISPLAYS

IBM monochrome display

The lower-frequency magnetic ELF fields (measured at 60 Hz in milliamperes per meter) generally proved weakest in front of the displays and strongest on the sides. The NEC MultiSync 3D generates a strong, nearly symmetrical field, while the original IBM monochrome display creates a much weaker field, principally on its right side. The fields of other displays fall between these extremes. System unit fields are weaker than those of the IBM monochrome display.



cancer promotion. In addition, ELF fields also disrupt the functions of cell gap junctions—another effect that has been associated with cancer growth.

Some studies of ELF fields have encountered an anomaly that complicates research, however. Normally, chemical carcinogens and ionizing radiation seem to act in an essentially linear way. That is, the dangers of each increase as the exposure level increases. While a number of ELF effects exhibit a similar intensity relationship, some studies have found what are called *window effects*. That's to say, some of the biological effects occur only at certain ELF field strengths (or frequencies) and not at higher or lower values. Additionally, these window effects appear to depend on the presence and orientation of static fields, like the earth's magnetic field. Thus, for example, one study (by C.F. Blackman, S.G. Benane, D.E. House, and W.T. Joines) on chick brain tissue showed changes in calcium ion flux with 60-Hz ELF fields at field strengths of 35, 40, and 42.5 volts per meter. At field strengths of 25, 30, and 45 volts per meter the same 60-Hz ELF radiation had no effect.

For health scientists, even the possibility of window effects is worrisome. If these effects are real (and doubts persist in many scientists' minds that they are), they would preclude the development of exposure standards. The effects of ELF fields would vary with the individual, because the size and shape of one's body affects the strength of voltages and currents induced inside it by the ELF fields.

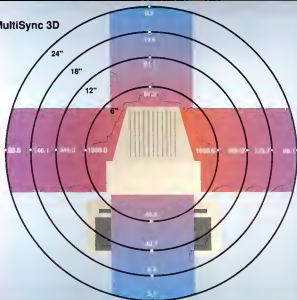
To complicate matters further, the waveform associated with ELF fields appears to affect their biological effects. Least active appear to be the sinusoidal waves that are characteristic of utility-supplied electricity. The most active appear to be pulsed fields like those generated by radar and fields with sawtooth waveforms, which are characteristically generated by the sweep circuitry of television sets and monitors.

PC Labs measured both the electrical and magnetic fields generated by several popular system units (these included an IBM PC-XT; IBM PC AT; Compaq Deskpro 386/25; and IBM PS/2 Models 30, 50Z, and 60) as well as the monitors we tested for other emissions. Measurements

were made with sensors optimized for two particular frequencies: those near 60 Hz, which are characteristic of power lines and the vertical scanning signals in monitors; and those in the range 10 to 40 kHz, which are characteristic of switching power supplies and the horizontal scanning circuitry of monitors. Measurements were made at four distances (6, 12, 18, and 24 inches) and from each side of each unit. At total of 80 measurements were made for each unit tested.

Detectable magnetic and electric fields in the lower frequency range were found with both computers and monitors. Higher-frequency fields were nearly absent in the measurements made of computer system units. As shown in the sidebar "The ELF Fields of Two Popular Displays," the strongest low-frequency magnetic fields were found above and on the left side of most monitors, although the IBM 8503 monochrome VGA display also had a strong field on its right side, and the NEC MultiSync had strong fields on both sides. The weakest fields in nearly every case were measured at the front of the unit undergoing evaluation. The field strength de-

NEC MultiSync 3D



clined with increasing distance. At a distance of 24 inches in front of the system units, field strengths were at or near the background reading of the test area. Monitors had fields that were sometimes pronounced at 24 inches, particularly at higher frequencies (The University of Toronto mouse study, which found no effects from VDT fields, concerned itself exclusively with these higher-frequency fields).

To put these observations in perspective, however, we found that the background magnetic field strength at 60 Hz at most locations in PC Labs exceeded the fields we measured 12 inches in front of most system units and the fields 18 inches in front of most monitors. This background field seems to originate in the ceiling wiring associated with the fluorescent light fixtures (it wasn't the tubes themselves, for the strength of the field did not decline when the lights were switched off). Thus, to judge on the basis of field strength, if you work more than 18 inches from your PC and its display, office wiring may pose more of an ELF threat than does your computer.

The fields associated with computer

equipment may nonetheless be biologically active, however. At normal working distances with some equipment, electric field strength appeared near the level at which an increase in ornithine decarboxylase activity was found in some studies. In another study, a similar field intensity was found to alter the cytotoxicity of T lymphocytes that specifically attack cancer cells in mice. Again, however, it must be emphasized that background fields present in the office were also observed at this intensity.

On the other hand, at distances greater than 6 inches, the strength of the electric fields associated with any of the tested equipment fell well below the field strengths found active in the Blackman study that found windowing effects. The magnetic fields measured appeared too weak to induce in the human body the fields observed to be active in the Blackman study.

To summarize, then, PC Labs did measure ELF fields at levels that some studies have associated with biological effects. Except at distances inappropriately close to the equipment, however, these fields

proved to be no stronger than the background fields in an office environment. If PCs pose an ELF risk—and if, indeed, there are any ELF risks—they are likely not the only source you'll encounter in your work.

THE NAGGING QUESTION

Are PCs safe? As far as x-radiation and ultraviolet are concerned, normal computer use probably poses no particular hazards. With regard to ELF fields, the situation is more equivocal. The effects of ELF fields have only recently become accepted by the scientific community, and field strengths that are or are not safe have yet to be determined. It may not be possible to determine safe ELF levels because of window effects.

If, based on the current state of research, you believe ELF fields are dangerous, you can take steps to minimize your exposure to them. For instance, sit in front of your computer and display, where the ELF fields are the weakest. Avoid sitting near the sides (particularly the left side) of nearby computer monitors. Because both the magnetic and electric ELF fields generated by computer equipment fall off quickly with increasing distance, you can minimize your exposure by working as far from your computer and its display as you can without having to squint or strain to reach what you need.

Monitors emit more ELF than do computer systems, and this radiation appears to be related to the scanning signals used by their CRTs. You can avoid the field associated with scanning signals (which may be more dangerous than the more pervasive sinusoidal waveforms) by using a display based on an alternative technology, such as an LCD display.

It's unlikely that your computer will kill you. Even if the worst of the effects attributed to ELF prove true, it's likely that you face greater health risks from other forms of pollution, such as the cigarette smoke you inhale (either your own or that of co-workers), the cholesterol in your bloodstream, and the peanut butter you spread on your nighttime sandwich.

Are the health risks of PCs and VDTs worth worrying about? Judge for yourself. But remember: stress is a likely cause of some of the health effects that have been related to computing, and worrying about it may increase your stress level. ■

Winn L. Rosch is a contributing editor of PC Magazine.

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CIRCLE 103 ON READER SERVICE CARD

Utilities

PC files grow like grass, even while you sleep. That's why your hard disk is always full. Yet every time you summon up your good resolve and delete a file you haven't used for more than six months, you can bet you'll need it again in less than six days.

The two programs that make up this issue's utility make it easier to live with these facts of life. PCMANAGE and DCOMPRES will convert your inactive files into a compressed format, then automatically reexpand them the moment you call them. The compressed files take up less space—in effect giving you a larger hard disk—yet they remain immediately accessible.

All compression techniques work by replacing repeated sequences of characters; using one code to represent many characters is the secret of compression routines. Fortunately, spreadsheets, word processing files, database files, and many executable programs (those with .COM or .EXE extensions) contain many repetitive strings. In spreadsheet and database programs a great deal of empty space is represented by ASCII nulls, spaces, and zeros. Similarly, in many executable files, the empty space allocated for local storage and the ubiquitous "stack" usually consists of multiple ASCII nulls. Word processor files often contain repetitive strings: certain words and letter sequences are obviously very common, as are the multiple spaces used to justify text.

PCMANAGE and DCOMPRES make use of the Lempel-Ziv-Walsh (LZW) algorithm, which has been made popular by such shareware programs as ARC (by System Enhancement Associates) and by PKARC (by Phil Katz).

You can set the drive and path across which the utility operates and the length of time you want files to lie dormant before they're considered inactive. You can also exclude specific files or directories to prevent certain files from ever being compressed. (You'll want to do this, for example, if you keep OS/2 files on your disk, since you'll never want these compressed under DOS.)

Compress and Expand The Files on Your Hard Disk Automatically

■ With PCMANAGE and DCOMPRES you can make room for all those files you want on hand but don't need to access every day.

DCOMPRES is a memory-resident (TSR) utility that tracks every access to every file on your disk. It takes up approximately 28K of RAM and should normally be loaded by a line in your AUTOEXEC .BAT file. DCOMPRES does two things. First, it creates and automatically updates a short (3,080-byte) file, INDEX.CMP, in each subdirectory. These INDEX.CMP files contain the date and time that each file was last accessed. PCMANAGE uses this information to determine whether or not to compress a file. When it does compress a file, PCMANAGE notes this in the INDEX.CMP file. This, in turn, enables DCOMPRES to do its second job: to decompress the files automatically when they're accessed.

The actual file compression is done by PCMANAGE. When you invoke PCMANAGE, you'll see a screen like the one shown in Figure 1 displaying the compression criteria you've chosen. The screen in Figure 1 indicates that PCMANAGE is using its default settings, which call for it to compress all files on drive C: that have not been accessed within the last 7 days, whose compressed version is at least 10 percent smaller than the original, and whose compression would free up at

least one cluster on the disk. Savings of less than one cluster (2K on most hard disks) are illusory, since DOS can't access smaller disk areas. Similarly, on anything less than an ultrafast 386, saving less than 10 percent of a file's space is probably not worth the expenditure of time.

PCMANAGE provides a full set of command-line arguments that let you modify its criteria for compressing files, but if you simply stick with the default settings and run PCMANAGE once a week or so you'll keep your disk storage at peak efficiency.

The easiest way to get copies of PCMANAGE.EXE and DCOMPRES.COM is to download them from PC MagNet, as explained in the sidebar "PCMANAGE and DCOMPRES by Modem." PCMANAGE.C and DCOMPRES.ASM, the source code for the two programs, are only excerpted here. However, they are available (along with the BASIC listings) from PC MagNet, or by sending a written request with your name, address and fax number (if applicable) to Utilities, One Park Avenue, New York, NY 10016; Attention: Carolyn Falconer. No phone calls please. (Note: estimated fax length is 40 pages.) You'll need both listings to modify either program.

Three caveats about the operation of PCMANAGE and DCOMPRES are in order at the outset: One is that, to keep its memory requirements small enough for it to be a TSR, DCOMPRES is designed to keep track of only the first 100 files in a given directory. Files in excess of this number won't be harmed, of course, but PCMANAGE won't save you disk space

Utilities



Figure 1: As PCMANAGE works, it reports its progress. The first section displays the compression criteria chosen. Here, the program is using the defaults. As PCMANAGE reviews each file to see if it's a candidate for compression, it lists the filename and last access date. It also indicates a file's status: for example, "skipped" means a file has been compressed; "bypassed" means it's in your exclude file. When it's perused all directories, PCMANAGE tallies its work on-screen.

by compressing them. Simply as a matter of ordinary file management it's generally a good idea to create new subdirectories when you accumulate more than 100 files in one place, but for some users this limitation may be bothersome.

The second limitation concerns compatibility with antivirus software. Since DCOMPRES will modify .COM and .EXE files when required, it should be installed in your AUTOEXEC.BAT file before any antivirus software you might use is invoked. Further, if your antivirus software does checksumming—that is, if it generates a unique signature for each file based upon the file's contents at the time you first run the antivirus program—you should set it to disable its checksum procedure until program execution time. If you're not sure if your antivirus software has this feature, you should check with the software manufacturer. Antivirus products that use checksumming but do not allow it to be shut off will conflict with the operation of DCOMPRES.

Finally, old-fashioned copy-protection schemes that create hidden files that check for specific locations of the installed program on the disk or perform checksums on

it will also present problems. The solution in such cases, as with OS/2 files, is to exclude them specifically from the utility's operations.

To exclude programs from being automatically compressed, you must create a file in the root directory called DCOMPRES.EXL. Use an ASCII editor or a word processor that can produce pure ASCII files. The DCOMPRES.EXL file may have up to 100 entries in it, one entry per line. Each entry can be a complete path or just a file or directory name; in the latter case all files in that directory and its subdirectories will be excluded from the compression operations of PCMANAGE. Moreover, your entry lines in DCOMPRES.EXL can use "wildcards" in a somewhat broader form than DOS normally allows. Thus, if you wanted to exclude all files on your disk that have a .SYS extension and every file in or under your C:\OS2 directory, you could include the following lines in DCOMPRES.EXL:

```
*.sys  
c:\os2\*
```

You may use an asterisk to mean "any

number of characters" and a question mark to represent any given character in a given location: ABC?EFG would allow for any character to match when surrounded by the "ABC EFG" string.

INSTALLING AND USING DCOMPRES

The full command syntax for the memory-resident DCOMPRES.COM is

```
DCOMPRES [/i] [/An]
```

The two optional switch parameters are both specifically related to the INDEX.CMP files. In default mode, DCOMPRES uses the entry in the INDEX.CMP file to determine whether or not a requested file needs to be decompressed. Therefore, if the INDEX.CMP file for a subdirectory is deleted or damaged, DCOMPRES will not know when a given file has been stored in compressed form, and the file would become unusable. However, by loading DCOMPRES with its /i switch, you can tell it to ignore the INDEX.CMP file and check every requested file directly to see whether or not it is compressed. Each file compressed by PCMANAGE will always start with the 8-byte sequence DCOMPRES. When loaded with its /i option, DCOMPRES.COM looks for this sequence and takes it as an instruction to decompress the file. Using the /i switch slows the processing slightly, but it gives you a fail-safe way to recover compressed files.

To protect against accidental deletion, the INDEX.CMP files are given a default read-only file attribute. This means, however, that in order to empty a subdirectory completely before removing it, you must change the attribute of its INDEX.CMP file to Read-Write so that you can delete it. Users of DOS 3.x can do this with the DOS ATTRIB command. If you're using DOS 2.x you can employ any of a number of utility programs, such as Charles Petzold's ATTR.COM (*PC Magazine*, June 10, 1986; also available for download from PC MagNet), to change the INDEX.CMP's Read-Only status.

But if you create and remove subdirectories frequently, this additional step may be more of a nuisance than the added protection is worth. For this reason, DCOMPRES has the /An switch, which allows you to select the file attributes that DCOMPRES gives the INDEX.CMP files. You can set the file attributes by substituting any of the following numbers for n: 0 (visible, read-write); 1 (hidden, read-

Utilities

write); 2 (visible, write-protected—the default); or 3 (hidden, write-protected).

After you put DCOMPRES into your AUTOEXEC, each time you access a file DCOMPRES creates an INDEX.CMP file in the corresponding subdirectory. However, neither DCOMPRES nor the INDEX.CMP file will have anything to do until a file is compressed. Putting them to work is the job of the transient part of the utility, PCMANAGE.

The syntax for PCMANAGE is

```
PCMANAGE [/l] [/dn] [/cn] [/bn]
[/pd]
```

As with DCOMPRES, all the arguments you provide to PCMANAGE are optional and, as the author is also a UNIX programmer, you may substitute a - for the more-familiar DOS / shown. Since remembering all these optional switches is not easy, if you simply enter PCMANAGE ? or PCMANAGE h—or any character or string the program does not recognize as one of its optional switches—you'll get a syntax screen that explains them.

The *n* in the various switches stands for a number you enter to replace the default value. Thus, if you want to restrict compression to files that have not been accessed for 30 days, you would enter PCMANAGE /d30. The values for /dn can range from 1 to 32767 (the default is /d7). The /cn switch sets the compression ratio—the percentage of compression that must be achieved before PCMANAGE will replace the original file on your disk with its compressed version. The default is /c10, the minimum permissible percentage is /c5. The /bn option allows you to adjust the minimum number of bytes that must be saved by compression to match the cluster size of your hard disk. The default is /b2048, but any cluster size from 1024 to 32767 can be specified.

The /pd switch allows you to set the drive and path on which PCMANAGE is to operate. The default is /pC:, which causes the utility to work on the C: drive and all directories (unless excluded by DCOMPRES.EXL), starting at the root and including all of its children. If you want to work only on the VOLD/DATA-BASE directory on drive D:, you'd enter

```
PCMANAGE /pd\OLD\DATABASE
```

THE MAIN ROUTINE

CODE EXCERPT (1 of 3)



```

#####
; Main routine.
;
; 1. Determine if a file or device. If device, return.
; 2. Determine if fixed disk. If not, return
; 3. Fully qualify file/pathname with undocumented AH=66h call
; 4. Save users PSP, reset with our own. Handle table in users might be
;    full...
; 5. Scan path name, isolate last '\ ' (separates path from filename)
;    saving the length of the path.
; 6. Save the path in one location, the filename is another
;    stuff the name of the index file to the tail of the path
; 7. Determine if this is the same index filepath as already loaded
; 8. If not, write file if needed.
; 9. Load new file. If not there, create one -- and dummy the file out.
; 10. Reset to the beginning of the binary tree index
; 11. Find the file in index. If found, then goto 14
; 12. File not in index. If room, add it and return; file has not been
;    compressed, obviously. New entry updated with current date and time.
; 13. If file not compressed, merely update date and time and return.
; 14. If file is compressed, check to make sure it is, then decompress it
;    into temporary file named PCOMPRESS.BFF and return
; 15. If, upon examination file is not a compressed one, reset to normal
;    status
;
#####

lookup:
    mov     cs:[vss_compressed], FALSE

    cld
    push    ax
    push    bx
    push    cx
    push    dx
    push    si
    push    di
    push    de
    push    es

    push    dx
    mov     ax, 8400h
    mov     bx, cs:[dos_handle]
    mov     cx, 2
    xor     dx, dx
    int     21h
    test    dx, 800h
    pop     dx
    ; loc1 call returns status
    ; in the dx register

    js      done2
    ; is a character device

00:    push    cs
    pop     es
    mov     si, dx
    mov     di, offset tmp_buffer
    mov     ah, 66h
    int     21h
    ; undocumented DOS call to
    ; fully qualify a file/path
    ; knows about SUBST and ASSIGN

    mov     di, es:[di]
    sub     di, 'A' - 1
    mov     ah, 1ch
    int     21h
    ; get the disk letter
    ; A=1, B=2, etc...
    byte ptr [bx], 010h
    ; on return, DS:BX points to
    ; first FAT entry. PB is fixed
    ; disk. Anything else, we skip

00:    mov     ah, 51h
    int     21h
    ; get users PSP, save
    ; then swap our's in.

    mov     cs:[users_psp], bx
    mov     bx, cs:[my_psp]
    mov     ah, 65h
    int     21h

<code removed from this listing. The code removed simply
separates a given file into its constituent members of path
and file name>

```

Figure 2: This is the primary routine used by DCOMPRES to determine whether a file is in the hash table and, if so, to decompress it if it's compressed. If it's not in the hash table, then it is inserted.

The HP DeskJet PL

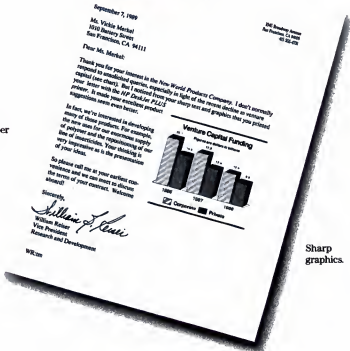
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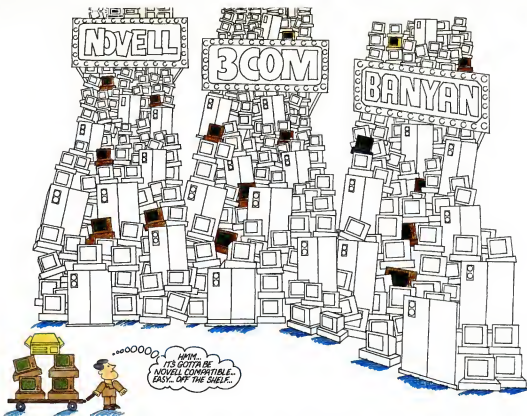
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Utilities

on the command line.

The /i switch of PCMANAGE (not to be confused with the /i switch used with DCOMPRES explained previously) can be thought of as an "install" option. PCMANAGE will not attempt to compress files you've never accessed since installing DCOMPRES. So you have to "fool" PCMANAGE into compressing your old files. One way of doing this would be to issue a COPY *.* NUL command in each directory. Easier still, is to use the PCMANAGE /i option. This will cause PCMANAGE to access every file on the specified hard disk. This might take a little while, but it need be done only when you first use DCOMPRES and PCMANAGE.

One additional reminder is in order: Once you have a compressed file on your disk, you *must* have the DCOMPRES program loaded from that point on if you wish to access that file. If you ever decide you want to remove DCOMPRES from your normal operation, rerun

```
PCMANAGE /i /pd
```

to cause every compressed file on your disk to be decompressed. Only then can you safely remove DCOMPRES from your AUTOEXEC file, delete your DCOMPRES.EXL file from the root directory of drive C:, and unprotect and then delete all your INDEX.CMP files.

A TRIAL GALLOP

Before you decide to install PCMANAGE and DCOMPRES systemwide and prepare a protective DCOMPRES.EXL file, you may wish to see the utility in action on a small scale. To do so, create a new subdirectory on one of your drives—I'll assume here that you make it C:\TEST—and copy into it a number of old data or document files, together with the .COM or .EXE files (such as your word processor) you would normally use to call up the old files. Put PCMANAGE and DCOMPRES in the root directory of drive C: (or in a subdirectory on your path, so DOS can find them) and issue the command CD C:\TEST to get into your trial subdirectory. Now, at the DOS prompt, enter DCOMPRES.

At this point you want to fool your machine (and PCMANAGE) into thinking it's a week, a month, or a year ago, so is-

THE MAIN ROUTINE

CODE EXCERPT (2 of 3)

```

;*****
; Same index name as last time
;*****
mov     si, offset cs:[dir_name] ; "old" filename
mov     di, offset cs:[dir_name2] ; "new" filename
mov     cx, cs:[tmp_len]
cld
rpb     cmovb byte ptr cs:[di], "I" ; pop out on no match
cmp     byte ptr cs:[di], "I" ; first letter of "INDEX.CMP"
jnz     cx, 0 ; not a match
jnz     cx, 0 ; all through and a match?
jnz     a_match ; yes
jmp     ; no match, fall through

;*****
; New index file. Close the old one first, then create a new one
; if needed with blank entries.
;*****

<code removed from this listing. The code removed will
create a new index file as required, padding out all
structure members as "empty" members. If an old index file
is set for read-only, this routine will reset it to read/write
for the duration of its being open.>

;*****
; At this point, the index is loaded into memory. Find the file
;*****

a_match:
mov     si, offset cs:[tmp_buffer]
add     si, cs:[tmp_len] ; pointer to filename
mov     di, offset cs:[file_name]
mov     cx:[file_seg], es
mov     cx:[file_off], di

@@:
mov     si, cs:[si] ; move filename again
mov     di, si
inc     di
inc     si
cmp     si, 0
jnz     @@

push     cs
pop     ds
mov     ax, 1 ; get first one
call    get_pointer ; bx gets pointer to entry

look_up:
mov     ds, cs:[file_seg] ; source seg
push     cs ; target seg - the buffer
pop     es
mov     si, cs:[file_off] ; get back the filename
mov     di, bx
add     di, filename ; and point to it in record
mov     cx, word ptr cs:[bx].filename_len
cmp     cx, 0
jz     no_match ; if empty record

@@:
mov     al, ds:[si]
cmp     al, cs:[di]
jnz     no_match ; try again
inc     si
inc     di
loop    @@

inc     cs:[dirty_bit] ; found it!
call    update ; a match. Update it.
jmp     done

done:
mov     bx, cs:[usare_psp] ; reset usare PSP and return
mov     ah, 05h
int     21h

done2:
pop     es
pop     ds
pop     di
pop     si
pop     dx
pop     cx
pop     bx

```

Utilities

use the DOS command DATE and supply, say, 1-1-80. Now enter

```
PCMANAGE /I /PC:\TEST
```

This will create the required INDEX.CMP file in your C:\TEST directory, with an entry for each file, but as yet, since PCMANAGE thinks they're all current, it won't compress them. So, bring your machine back up to date by issuing the DATE command again and entering today's date. Now enter

```
PCMANAGE /PC:\TEST
```

All the files in the subdirectory to which you have restricted PCMANAGE's operations are now old enough to be compressed, though some of them may be too small to save a cluster's worth of space, or may not meet the test for saving 10 percent in compressed form. As it compresses files, PCMANAGE will give you an ongoing report of its activities. When it's through, if you TYPE a document file to the screen, you'll get a good idea of how quickly DCOMPRES can reexpand a compressed file.

When you bring up your word processor in the \TEST subdirectory it will take a little longer than usual to load *this time*; for it, too, was compressed in the trial. Ordinarily you'll use the program often enough so that PCMANAGE will never consider it a candidate for compression in the future. As you call up various old file copies, you'll get a screen message while they are being decompressed, but all will thereafter behave normally. A few experiments with your DATE command, these test copy files, and PCMANAGE's /dn switch, and you'll have a feel for how the utility works. Don't forget to include the /pc:\TEST switch every time you invoke PCMANAGE during this test run! By default it's set to run through your entire C: drive.

After test-driving PCMANAGE and DCOMPRES, you should delete the files in C:\TEST (you'll have to use ATTRIB to unprotect INDEX.CMP before you can erase it). If you've called any files from any other subdirectory, there will also be an INDEX.CMP in that subdirectory you'll want to eliminate. You can now reboot your machine to take DCOMPRES out of memory and go through the normal

THE MAIN ROUTINE

CODE EXCERPT (3 of 3)

```
pop ax
ret

; Current entry isn't what we want. Try next one.
; Current entry isn't what we want. Try next one.
no_match:
push cs
pop ds
mov ax, [bx].left_ptr ; assume less than
mov dx, left_ptr
jl 8F ; greater than, use right
mov ax, [bx].right_ptr ; pointer
; end of the line?
00: cmp ax, 8
je 8F ; yes
call get_pointer ; bx points to next entry
jmp look_ip ; see if a match

; insert routine
; insert routine
00: cmp cs:[num_files], MAX_FILES ; full already?
jne 8F ; no
jmp done ; yes. Ignore it.
inc cs:[num_files] ; increase the count
mov ax, cs:[num_files]
add bx, dx ; left or right pointer offset
mov cs:[bx], ax
inc cs:[dirty_bit]
call get_pointer ; point to empty record

; copy the name into the buffer
; copy the name into the buffer
mov ds, cs:[file_seg] ; source seg
push ca ; target seg - the buffer
pop es
mov si, cs:[file_off] ; get back the filename
mov di, bx
add di, filename
xor cx, cx
cld
movsb
inc cx
cmp byte ptr ds:[si], 0
jnz 8B

; set up the rest of the entry
; set up the rest of the entry
mov byte ptr es:[di], 0 ; trailing null: nice for 'C'
mov cs:[bx].filename_len, cx
mov cs:[bx].left_ptr, 0
mov cs:[bx].right_ptr, 0
mov cs:[bx].access_cnt, 1
mov cs:[bx].status, NORMAL
inc cs:[dirty_bit]
call update
jmp done ; add date and time
```

installation process to implement these utilities's operations systemwide. And if you have any files or directories to exclude, be sure to create a DCOMPRES.EXL file, as described previously, before running PCMANAGE.

PROGRAMMING PCMANAGE/DCOMPRES

The Lempel-Ziv-Walsh (LZW) compression algorithm was selected because it seems to offer the best overall performance, given equal chances that a file to be compressed might be either ASCII or bina-

ry. It would, perhaps, have been nice to write the program in such a way that it would test each of the compression methods (such as RLL and Huffman encoding) and select the best on a file-by-file basis. The popular ARC and PKARC programs do just that. In this case, however, since the decompressor routine in DCOMPRES had to be a TSR, a single algorithm had to be selected to minimize the memory demand on the valuable 640K.

Having selected a compression algorithm, all I had left to do was to find a way

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Utilities

for DCOMPRES to track the last date and time of a file's access for the compressor, and then decompress a file when required.

Finding the best way to keep track of a file's last access time, however, turned out to be anything but an easy task. The place to start would seem to be with the DOS directory entries, which already contain the filename, size, date, and time of last modification, file attributes, and starting cluster on the disk. You'd think it would be a trivial matter to insert the information about the file's last read access into the reserved bytes in a file's directory entry.

Unfortunately, however, DOS goes out of its way to make writing to these reserved bytes difficult—even though they've never been used in any DOS version in existence. (They probably never will be, since there's a good chance that future versions of DOS will not have a compatible directory structure.) After examining any number of ways in which the needed information could have been written to this area, I came to the rueful conclusion that they were all either too slow (required multiple disk reads), were DOS-version sensitive, or might cause problems with some of the many special device drivers and weird partitioning software used in the real world.

In the end, then, I decided on the simplest method: to create a file containing all of the access information required and forget the reserved bytes. The question then became whether it was better to have one index file for each disk or to have separate index files for each subdirectory.

Using a single large index file would require storing the full pathname—up to 64 bytes—for each file. My own C: drive, a 32MB partition of an 80MB disk, contains some 2,000 files. $64 \times 2000 = 128K$ of pathname information alone. Since its TSR status requires that DCOMPRES be kept as small as possible, only a portion of such an index file could be brought into memory at any given time. In order to access all the filenames in the index, pieces would have to be flipped in and out. This was so time consuming that it slowed down the operation of an early version of DCOMPRES by an astounding 500 percent! And that was on a 386 machine with a large disk cache.

This was enough to convince me what DCOMPRES should do. The 128K of pathname overhead is eliminated by open-

LZW COMPRESSION ROUTINES

CODE EXCERPT (1 of 3)

```

; LZW compression routines
;
; zero out the table.
;
init_tab proc    near
    push    ax
    push    cx
    push    si
    push    ds

    xor     ax, ax
    mov     cx, 256
    mov     si, offset cs:codes
    push    cx
    pop     ds

lp:
    mov     [si].cmp_code, 0
    mov     [si].suffix, si
    inc     si
    add     si, size table
    loop    lp

    mov     cs:[codes_used], 256

    pop     ds
    pop     si
    pop     cx
    pop     ax
    ret
init_tab endp

; Actual decompression routine
do_decomp proc    near

    call    paint                ; XT owners don't think we
                                ; crashed...

    call    init_tab

    mov     cs:[which_code], 0    ; initialize a bunch of variables
    mov     cs:[hold], 0
    mov     cs:[a_ptr], offset cs:stack ; not a real stack
    mov     cs:[out_cnt], 0
    mov     cs:[buff_cnt], 0
    mov     cs:[buff_size], 0
    mov     cs:[tmp], 0

    push    cs
    pop     ds

    mov     dx, offset cs:dir_name1 ; creates the temporary file
    xor     cx, cx
    mov     sh, #1ch
    int     21h
    mov     cs:[out_handle], ax

    call    get_code              ; read a code in
    mov     bl, al                ; save it
    call    stuff                 ; stuff on the stack
    call    unstuff               ; unstuff into the output file
    mov     cs:[old_code], ax     ; save it
    mov     cs:[last_char], bl    ; save it

drcode:
    call    get_code              ; loop: get a code, expand it
    jg     exit                   ; we're done or carry
    cmp     ax, RESET_TABLE      ; table full in compressor?
    jns     no_exit

    call    init_tab              ; yes. Reset everything

    call    get_code              ; and start over
    mov     bl, al
    call    stuff
    call    unstuff
    mov     cs:[old_code], ax

```

Figure 3: The decompression routine for DCOMPRES, written in assembly language, complements the C-based compression procedure (shown in Figure 5) used by PCMANAGE.

Utilities

ing a separate INDEX.CMP file in each subdirectory, containing just the filenames and all the access information for the files in that directory. It works, and it's fast.

A WALK THROUGH DCOMPRES

DCOMPRES is the TSR portion of the package. To save memory space, it is written in assembly language. Although it's easier to write TSRs in higher-level languages such as C, the overhead of the higher-level language's runtime library routines makes the resulting file substantially larger than an equivalent assembly language program.

The typical TSR determines whether the TSR routine is already running (and exits with an error message if it is), preserves the current address pointed to by an interrupt, replaces the address with one pointing to our own routine, prints a welcome message, and exits through a TSR call that allocates all of the memory required for the program to run. DCOMPRES is entirely conventional in this respect. Once the program has gone TSR, it does nothing until the revector interrupt is called.

DCOMPRES works by taking over the vector for interrupt 0x21, the main DOS interrupt. Whenever a file is to be accessed, the DS:DX registers are made to point either to the null-terminated ASCII filename or to a special structure called an FCB. Simply by calling DOS with DS:DX set up properly, the file is opened or otherwise accessed. DCOMPRES intercepts the return from the open call to DOS and catalogs the access.

The routine called `new_dos` is the entry point to DCOMPRES once it has become a TSR. Upon getting a DOS call, the current state of the processor flags is saved, interrupts are turned back on (generating an interrupt always turns off interrupt processing), and a check is made to see whether it is a new DOS call that will be needed later. If not, the AH register is checked to determine if it is a call in which DCOMPRES is interested. If not, the flags are popped back off the stack and DOS is called as if DCOMPRES didn't exist.

Assuming the call in question is a simple handle open call, a jump is made to the `h_open` routine. Since this routine is shared by multiple function calls to DOS, the actual call is preserved to mark its presence (so it doesn't call itself recursively).

LZW COMPRESSION ROUTINES

CODE EXCERPT (2 of 3)

```

        jmp      decode          ; now we're back to normal

exit:
        call     output          ; exit. Force output of last code
        mov      bx, cs:[out_handle]
        mov      ah, 03ah
        int      21h            ; close decomp'ed temp file

        mov      cs:[was_compressed], TRUE

        call     print           ; Yoi XT owner! Wake up!
        ret                     ; good-run exit point

no_exit:
        mov      ax:[incode], ax      ; save the code
        cmp      cx, cs:[codes_used]  ; already in table?
        jl       $F              ; yes

; ; ; ; ;
; ; Special class of codes for highly repetitive strings. The code can
; ; be transmitted before it exists! So, we simply add a new code
; ; ; ; ;
        mov      ax, cs:[old_code]
        mov      bl, cs:[last_char]
        call     stuff

@@:
        push     ax               ; save the code
        mov      cx, size tabla
        mul      cx
        mov      si, ax
        add      si, offset cs:codes
        pop      ax
        cmp      ax, 256         ; "low" code?
        jl       $F             ; yes, and loop
        mov      bl, cs:[si].suffix
        call     stuff           ; antsr onto stack
        mov      ax, cs:[si].cmp_code
        jmp      $B             ; loop

@@:
        mov      bl, cs:[si].suffix
        mov      cs:[last_char], bl
        call     stuff           ; add to stack
        call     unstuff         ; writa out whole stack

        cmp      cs:[codes_used], MAX_CODE ; full tabla?
        je       $F             ; yes

; ; ; ; ;
; ; Add the code into the tabla
; ; ; ; ;
        mov      ax, cs:[codes_used]
        mov      cx, size tabla
        mul      cx
        mov      si, ax
        add      si, offset cs:codes
        mov      ax, cs:[old_code]
        mov      cs:[si].cmp_code, ax
        mov      al, cs:[last_char]
        mov      cs:[si].suffix, al
        inc      cs:[codes_used] ; up the number of codes used
                                   ; in table

@@:
        mov      ax, cs:[incode]    ; save original code
        mov      cs:[old_code], ax
        jmp      decode           ; next!

do_decomp endp

; ; ; ; ;
; ; The codes are actually 12 bit entities: a byte and a half. So, take
; ; turns reading two bytes, returning 12 bits, then one byte, returning
; ; old half byte (e nibbla) and new byte. That's a code. And it fits
; ; within a register. How nifty!
; ; ; ; ;
get_code:
        cmp      cs:[which_code], 0 ; even or odd code?
        jnz      odd_code

        call     get_byte         ; get the first byte
        jc       get_code_ret    ; eof

        xor      ax, ax
        mov      al, byte ptr cs:[tmp] ; get byte
        mov      cl, 4
        shl      ax, cl          ; end pop it down e nibbla

```

Utilities

and DOS is called as a subroutine. All of the handle calls return the handle in the AX register, and the handle is saved immediately upon a successful call. If the call is unsuccessful, it simply returns, resetting the `in_use` flag as it exits back to the user program.

The lookup routine, excerpted in Figure 2, is the heart of the program and it should be examined in detail.

The lookup routine saves all of the registers and calls an IOCTL on the returned handle from DOS. This will determine if the handle represents an open device (such as CON, COM, AUX, PRN, NUL, or a user-defined device). Since there can't be any compression on a device, if the device bit is set in the return of the IOCTL call, we simply return.

If the handle does not point to a device, then it must point to a file. The user program's Program Segment Prefix (PSP) contains the actual handle information. We don't want to disturb this (it might not have room for what we need to do anyway), so we preserve the current PSP address and replace it with our own, which was originally saved in the install routine.

At this point DCOMPRES enters the risky world of undocumented interrupts. Microsoft might one day change DOS in such a way that all the programs that use these undocumented interrupts will immediately cease to work. The odds of this happening are remote, however; you'll not be alone if you continue to use those undocumented interrupts that should long since have become a formal part of DOS.

AH=0x50 and AH=0x51, for example, let programmers get and set the PSP. Without them, programs like DCOMPRES would have to resort to a variety of nasty workarounds. Yet, these calls (which exist in DOS 2.x, 3.x, and 4.x) aren't documented. (In DOS 3.x and 4.x at least one equivalent call is documented.) We need them, so we'll use them.

After the PSP's are swapped, another undocumented call is made. It happens that given a null-terminated filename or partial pathname pointed to by DS:SI and a buffer of up to 2+64+14 bytes (that is, the drive letter and colon + pathname + filename, period, extension and null), a call to DOS with AH=0x60 will generate the fully qualified physical pathname to that file. This powerful call works even with

LZW COMPRESSION ROUTINES

CODE EXCERPT (3 of 3)

```

call    get_byte          ; get next byte
jc      get_code_ret      ; eof
mov     bx, ax
xor     ax, ax
mov     si, byte ptr cs:[tmp]
mov     cs:[hold], ax
and     cs:[hold], 0fh     ; set the leftover flag.
cld
shr     ax, cl
or      ax, bx
mov     cs:[which_code], 1
cld
jmp     get_code_ret

odd_code:
mov     ax, cs:[hold]     ; retrieve left over nibble
mov     cl, 8
shl     ax, cl            ; pop it up
call    get_byte         ; get next byte
jc      get_code_ret      ; eof? Shouldn't happen
or      si, byte ptr cs:[tmp] ; add it in
mov     cs:[which_code], 0 ; set for even read next time

get_code_ret:
ret                                ; code in ex

;-----
;; character in bl gets stuffed onto stack
;-----
stuff:
push    si
mov     si, cs:[s_ptr]
inc     cs:[s_ptr]
mov     byte ptr cs:[si], bl
pop     si

;-----
;; Get characters off stack in reverse order. Add to buffer. Write buffer
;; if it gets too large
;-----
unstuff:
push    ex
push    bx
push    si

mov     si, cs:[s_ptr]

unstuff_lp:
dec     si
cmp     si, offset cs:stack
jl      unstuff_end
cmp     cs:[out_cnt], INBUF_SIZE
jns     @f
call    output
00:     mov     si, byte ptr cs:[si]
mov     bx, cs:[out_cnt]
inc     cs:[out_cnt]
add     bx, offset cs:out_buf
mov     byte ptr cs:[bx], si
jmp     unstuff_lp

unstuff_end:
mov     cs:[s_ptr], offset cs:stack ; reset the stack
pop     si
pop     bx
pop     ex
ret

```

SUBST, with network drives, and with all the shenanigans a programmer or weird extension to DOS might pull. Yet it remains an undocumented call all the same. Use it with caution—but use it anyway.

After pathname qualification, the actual disk is examined to determine if this is a floppy disk drive or the hard disk. If it's a floppy, we simply return doing nothing: DCOMPRES is for hard disks only.

The pathname and the filename are separated by locating the last \ in the temporary buffer. The filename is stored in one area, the pathname in another, and the pathname is then compared with one stored in the `dir_name2` variable. If they match, then we haven't changed directories and we can proceed.

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dex file in the old path is updated as needed and then closed. An attempt is made to open the index file in the new directory. If the index exists, it is read into the buffer, along with the previously preserved path-name. If the index doesn't exist, it is created, and the contents of the buffer are set to zero. Finally, the new path is written into the `dir_name2` variable and the contents of the `num_file` variable through the end of the newly zeroed buffer are written out to disk.

At this point, whether the index file existed or not, we're at the `a_match` label in Figure 2. The filename is moved from the temporary buffer into the `file_name` variable, and then the now-in-memory index is examined to see if the filename already exists in it.

The buffer contains up to 100 structures of the type "file". This structure has entries for the filename, the length of the filename, date and time of last access, the status and access count of the file (both discussed below), and two pointers to other members of the index file. The buffer is structured as a binary tree. A binary tree is simple in concept: each node on the tree has pointers to the left and to the right. Left pointers point to the members of lesser value than the parent, right pointers point to nodes with greater values than the parent.

Traversing and updating the tree is easy enough: the `file_name` contents are compared with the filename contents of a node. If there's a match, the date and time of last access is updated. If there is no match, the value in the target node is determined to be less than or greater than that of the current node. The pointer is then reset appropriately and the process continues until the proper node is reached or the end of a branch. If the latter is the case, the next unused node is used (if one exists) to hold the information for the file in `file_name`, and the parent node's appropriate pointer is reset to the freshly allocated and filled-in node.

Whenever a new node is inserted into the tree or an old node is updated, the dirty-bit variable is set, and the modified contents of the buffer will be written out to disk before the file is closed.

In this version of DCOMPRES, only the first 100 files in any given directory will be indexed; subsequent entries will be ignored. Although it would be possible to allow for more entries, this would impinge

on the amount of memory justifiably allocated to a TSR program.

If a file's entry is found in the buffer, it is checked to see if its status byte indicates that the file is compressed. Inclusion of the `/i` switch when loading tells DCOMPRES to make every file a candidate for decompression, not just the ones with the COMPRESS bit set in their index entry.

If the status byte indicates the file is compressed, it is decompressed in the `do_decomp` routine (see Figure 3) and a flag is set to indicate the file was compressed.

Eventually, it returns from the lookup

routine, resetting all of the registers from the stack. The decompression flag is examined and, if set, the file in the user's space is closed and the compressed version is deleted. The decompressed version of the file, contained in a file called `DCOMPRES.$$$` in the target directory, is then renamed to the original filename requested by the user program and the original DOS operation is executed again, using the previously saved function code. Eventually, the call to DOS returns to the user program and the user program executes normally as if the file had never been

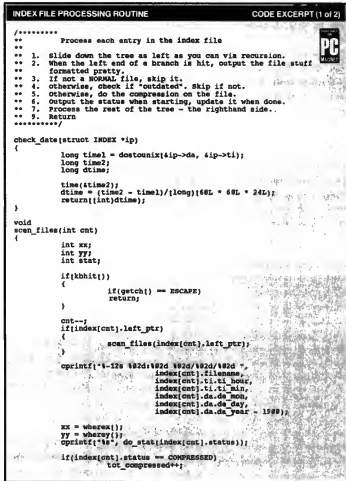


Figure 4: PCMANAGE scans each file in the INDEX.CMP file to see if the file is old enough for compression. This is a recursive routine, since (as a transient program) it has all the stack space it needs. The compress check is done only on "normal" files.

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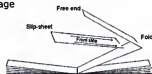
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compressed. The only cost was the delay time in decompressing the file.

PCMANAGE

Since PCMANAGE is run only as a transient program, I was able to write it in Turbo C. That makes things a little easier to understand when you look at the code. And certainly it was easier to write.

PCMAIMAGE opens the INDEX.CMP file in each directory it examines on a specified drive and compares the last date and time of each file's entry with the current date and time. If the difference exceeds the default 7-day threshold (or the time-frame set with the command-line /dn switch), the file is compressed into a temporary file. If the difference in size between the temporary file and the original file exceeds 10 percent and is at least one cluster size or larger (or meets criteria specified by the /cn and /bn switches) the original file is deleted and the compressed file is renamed in its stead. This compression is noted in the status byte of the INDEX.CMP file so that DCOMPRES will know to decompress the file when an access is made to it.

The main() routine takes care of any optional line arguments. The memory required for various structures is allocated so that the storage space does not become part of the disk image of the file. This speeds program downloading from PCMagNet. Control-C trapping is implemented in order to allow the DCOMPRES program to be toggled on or off as required. (DCOMPRES is turned off at runtime of PCMANAGE.)

Walking through the entire directory structure of your hard disk is done by the `do_dir()` routine. By using the DOS `find` and `find next` functions, each directory is scanned for directories other than `"."` or `".."`. If there is an `INDEX.CMP` file in a directory, it is found and scanned via the `do_index` and `scan_files()` routines, respectively.

The `scan_file()` routine, shown in Figure 4, examines the contents of the `INDEX.CMP` file, walks the binary tree therein, and attempts compressions on the files contained within the index file. The compression is done by the `compress()` routine, which is shown in Figure 5.

The only part of the compression routine that is a little unusual is the hash-table lookup of a used code-suffix pair. Since

INDEX FILE PROCESSING ROUTINE

CODE EXCERPT (2 of 2)

```

else
if(index[cnt].status == LOW) {
tot_bypassed++;
}
else
if(index[cnt].status == NORMAL &&
check_date(&index[cnt]) >= daya)
{
gotoxy(xx, yy);
printf("de %at(Testing);
stat = compress(&index[cnt]);
window(2, 11, 78, 15);
gotoxy(xx, yy);
printf("%a", do_atstat(atat));
}
if(++ascen_cnt < 2);
putch('\n');
else
putch(VERICAL);
if(index[cnt].right_ptr)
{
scan_files(index[cnt].right_ptr);
}
return;
}

```

LZW MAIN ROUTINE

CODE EXCERPT (1 of 2)

```

*****
**      LEW main routine
**
**  1.  if the file is on the archive list, return without processing
**  2.  open the file and get the file length
**  3.  Open the scratch file and write our tag. The tag starts with an
**      32 bit exit instruction in case a PCOMPRESS file is run without
**      PCOMPRESS running, no system hang.
**  4.  Initialize everything and read the first character from the file
**  5.  Put each character in the file; if the character and last code
**      are already in the table, get the next character and try again.
**  6.  If there isn't room in the table to stuff the new combination,
**      output a reset code, reset the table and continue.
**  7.  Print out pretty stuff when enough data has been processed
**  8.  When finished with the input character, output the last code
**      and a compression ration. If enough, remove the original
**      input file, reset the status byte on this file's index entry.
**      Otherwise, simply removes the temp file.
**  9.  Return
*****
compress(struct INDEX *ip)
{
    char      fname[MAX_FILEN + MAX_FILEN];
    int       tmp_name[MAX_FILEN + MAX_FILEN];
    int       fd1;
    int       fd2;
    char      c;
    int       tmp_code;
    long      file_len;
    int       each_char;
    struct    ftime   ft;

    if (enclude(ip->filename))
    {
        return(skipped++);
        return(SKIP);
    }
    tmp_examine++;

    window(2, 17, 79, 23);
    clrscr();
    gotoxy(8,1);
    printf("We out of %d files processed. Total bits compression,\n");
    printf("saved::"); tmp_examine + tmp_skipped, num_files,
        Total_in_cnt * ftime(188 * Total_in_cnt -
            Total_out_cnt)/Total_in_cnt + 8,
            Total_in_cnt - Total_out_cnt);

    in_cnt = out_cnt = 0;
    sprintf(fname, "%s", only_dir, ip->filename);
    sprintf(tmp_name, "%s", only_dir, "COMPRESS.958");

    if (fd1 = open(fname, O_RDONLY | O_BINARY)) == -1)

```

Figure 5: PCMANAGE uses this routine to compress each file and then check the resulting compression against the various parameters given by the user. Specifying certain parameters will allow this routine to remove the source file and rename the compressed file to the original's name.

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The programs published in *PC Magazine* are available by modem from PC MagNet.

To download PCMANAGE, EXE and DCOMPRES.COM, log on to PC MagNet. Enter GO UTILITIES or choose PC MAGAZINE UTILITIES from the top menu, then DIRECT UTILITY DOWNLOAD from the next. Enter the filename, then select the file from those presented. Answer (Y) to DO YOU WISH TO DOWNLOAD? Press Enter to see the transfer protocols. Choose a protocol and download the file.

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PCMANAGE and DCOMPRES

Ross M. Greenberg

December 12, 1989 (Utilities)

Purpose:

To provide automatic compression of infrequently accessed files and automatic decompression when they are called. The user can set the inactive period necessary before a file is compressed, can restrict the drive and/or path of operation, and can specifically exclude named files or directories.

Format:

DCOMPRES [/i] [/An]

Remarks:

DCOMPRES is a memory-resident program that should be loaded from an AUTOEXEC.BAT file. In each subdirectory it creates and maintains a file called INDEX.CMP. This file stores the date and time each file was last accessed and whether or not the file is compressed. When a compressed file is called, it decompresses it automatically.

INDEX.CMP files are normally created with a read-only file attribute, as they should never be deleted while any compressed files remain in the directory. To remove a directory requires changing this file attribute with the DOS ATTRIB command (for DOS 3.x) or with a utility such as ATTR.COM (*PC Magazine*, June 10, 1986). INDEX.CMP files can be created with other attributes by loading DCOMPRES with its optional /An switch, where n has one of the following values: 0 (visible, read-write); 1 (hidden, read-write); 2 (visible, read-only—the default); or 3 (hidden, read-only).

If an INDEX.CMP file is accidentally deleted or damaged, all compressed files in a directory can be restored by loading DCOMPRES with its optional /i switch parameter or by issuing a command such as COPY *.* NUL.

Format:

PCMANAGE [/i] [/dn] [/cn] [/bn] [/pd]

Remarks:

When invoked with its default settings, PCMANAGE compresses all files on drive C: (including those in all subdirectories) that have not been accessed in 7 days and whose compression will save at least 10 percent in file length and 2,048 bytes (nominally one cluster). The user can change the number of days before compression by employing the optional /dn switch with values from 1 to 32767 for n. Similarly, the optional /cn switch sets the minimum acceptable compression percentage and accepts any n value of 5 or greater. The /bn switch sets the number of bytes in one disk cluster (the minimum real saving possible); it accepts values from 1024 to 32767 for n.

CONTINUES

Utilities

PCMANAGE and DCOMPRES
BY MODEM

The optional `/pd` switch, with an appropriate drive letter (and/or path) entered for *d*, allows PCMANAGE to be used on drives other than C: and permits restricting its operations to the files along a specific path (and its subdirectories).

The `/i` switch is used with PCMANAGE when installing the utility. This should not be done until after you have prepared any necessary DCOMPRES.EXL (exclude) file, as described in the Notes below. This done, and with DCOMPRES loaded, use the DOS DATE command to set the current date back by at least one week. Then enter PCMANAGE `/i`, which will cause it to examine all files on drive C: (or as modified by the `/pd` switch). Use the DATE command to reset the present date and run PCMANAGE again, without the `/i` parameter. All files on the drive except those excluded by DCOMPRES.EXL or the optional `/pd` switch will now be compressed initially, if warranted by the disk space savings. The files will be decompressed as soon as accessed, and programs called frequently will not be compressed again.

Running PCMANAGE weekly will automatically cause files that have become stale-dated to be compressed.

- Note 1:** Up to 100 files or directories (and child directories below them) can be excluded from possible compression by PCMANAGE. All OS/2 files and copy-protected software should be so excluded. To do so, create a pure ASCII file called DCOMPRES.EXL in the root directory of drive C:. List one entry per line. To exclude all files that have a .SYS extension and all files in and under an OS2 directory on drive C:, the DCOMPRES.EXL file would have two entries:

```
*.SYS
C:\OS2\*
```

- Note 2:** PCMANAGE and DCOMPRES can handle a maximum of 100 files per directory. Files in excess of this number will not be harmed, but will not be processed.

- Note 3:** DCOMPRES should be installed in the AUTOEXEC.BAT file before any antivirus software. Antivirus software that uses checksumming procedures that cannot be disabled until program execution time is incompatible with DCOMPRES.

charge is involved, but making copies for any commercial purpose is prohibited.

Like all good software, the programs presented in *PC Magazine* get upgraded and improved. The only way to obtain the modified versions is to download them from PC MagNet. Here is a partial list of the programs that have been upgraded to fix minor bugs and system incompatibilities. For a complete list of all the programs in the Utilities Database download UDCAT.ARC.

ANSI.COM, Version 1.3
CARDFILE.COM, Version 1.1
CHKFRAG.EXE, Version 1.2 (now works with volumes greater than 32 MB)
DIRMATCH.COM, Version 1.1
EMS40.SYS, Version 1.1 (fixes a problem that EMS40 had with Lotus 1-2-3)
LITES.COM, Version 1.1
LOG.COM, Version 1.1
RN.COM, Version 2.0 (now works under DOS 4.x)
SLICE.COM, Version 1.3
SNIPPER.COM, Version 1.2
ZCOPY.COM, Version 1.2

Also available: PCME.EXE—a self-extracting file that contains the Computer Library *PC Magazine* Reviews Index for 1/88 to 6/89. This easy-to-use database is a subset of the Computer Library Periodicals Database, which is available on CD-ROM and on PC MagNet (GO COMPLIB). It requires the search files in PCSRCH.EXE.

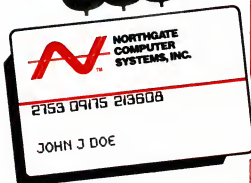
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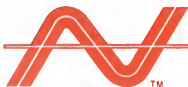
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Applicants must be 18 years of age or older.

a. Your Personal Information		Requested Line of Credit \$ _____	
Your Name: First _____ Initial _____ Last _____		Date of Birth: _____ Mo _____ Day _____ Yr _____	
Present Address: Street _____ Apt # _____ City _____ State _____ Zip _____		Social Security Number: _____	
Date of Residence: Month _____ Year _____		Name Phone: () _____	
Previous Address: _____		Monthly Payment \$ _____ Buy _____ Rent _____ Other _____	
Your Employer: (If self employed, see rear panel) _____		Date of Residence: From _____ To _____	
Employer's Address: Street _____ City _____ State _____		Date of Employment: _____ Mo _____ Yr _____ Position: _____	
Promissory Note: _____		Monthly Income: Gross \$ _____ Net \$ _____	
Other Income: _____		Business Phone: () _____	
Income from annuity (child support or separate maintenance payments need not be disclosed if you do not wish to have it considered as a basis for requesting financing) _____		Dates of Employment: From _____ To _____	
Name and Address of Nearest Relative Not Living With You _____		Monthly Income Gross \$ _____ Net \$ _____	
		Relationship _____	

b. Credit Information		Include joint applicant's information, if joint account requested.	
Bank Account: _____		Address: _____	
Bank Account: _____		Checking <input type="checkbox"/> Savings <input type="checkbox"/>	
Bank Loan Reference: _____		Checking <input type="checkbox"/> Savings <input type="checkbox"/>	
Bank Card Reference: _____		Payment _____ Balance _____	
Other Card Reference: _____			
Other Card References: _____		Account No. _____ Expires _____	
Driver's License No. _____		State _____ Expires _____	

c. Joint Applicant's Personal Information		If you are a married Wisconsin applicant, you must provide your spouse's information below, even though your spouse may not be signing this contract.	
Joint Applicant's Name: First _____ Initial _____ Last _____		Date of Birth: _____ Mo _____ Day _____ Yr _____	
Address: Street _____ Apt # _____ City _____ State _____ Zip _____		Social Security Number: _____	
Employer: _____		Date of Residence: _____ Mo _____ Yr _____	
Employer's Address: Street _____ City _____ State _____		Position: _____	
		Monthly Income: Gross \$ _____ Net \$ _____	
		Business Phone: () _____	

d. Self-Employed Information		Complete this section only if you are self employed.	
Business Name _____		Proprietorship <input type="checkbox"/> Corporation <input type="checkbox"/> Partnership <input type="checkbox"/>	
Business Address _____		Business Telephone: () _____	
Description of Business _____		In Business Since _____	
Your annual income from business _____		Business annual income (gross) _____ (net) _____	
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LZW MAIN ROUTINE

CODE EXCERPT (2 of 2)

```

{
    fprintf(stderr, "can't open: %s\n", fname);
    return(ERROR);
}

gettime(&dt, &ft);
file_len = filelength(&fd1);
each_char = max((int)(file_len / 512), 1);
unlink(tmp_name);

if(&fd2 = open(tmp_name, O_CREAT | O_RDWR | O_BINARY,
               S_IRUSR | S_IWUSR)) == -1)
{
    fprintf(stderr, "can't open: %s\n", tmp_name);
    close(&fd1);
    return(ERROR);
}

write(&fd2, "\x0d\x26PCOMPRES", 16);
init_table();
stuff(NULL, NULL, RESET);
get_char(RESET, NULL);
reset = 0;

get_char(&fd1, &c);
oldcode = c;
in_cnt = 1;
while(get_char(&fd1, &c))
{
    in_cnt++;
    if((tmp_code = get_code(c)) != IN_TABLE)
    {
        stuff(&fd2, tmp_code, NORMAL);
        if(codesused == RESET_CODE)
        {
            stuff(&fd2, RESET_CODE, NORMAL);
            init_table();
            reset++;
        }
    }
}

if(!(in_cnt % each_char))
{
    gotoxy(2, 3);
    percent = (int)((100 * in_cnt) / file_len);
    fprintf(stderr, "Compressing: %s - %2.2d%% Complete, %u Codes Used",
            fname, percent, codesused * (reset * MAX_CODE));
    percent = (int)(100 - (100 * out_cnt) / in_cnt);
    gotoxy(2, 4);
    fprintf(stderr, "Compression of %2.2d%%, %u Bytes Saved.\n",
            percent, in_cnt - out_cnt);
    gotoxy(2, 6);
    fprintf(stderr, "Input Bytes: (%7.1d)", in_cnt);
    bar_char((int)(in_cnt / (long)each_char), &xb1);
    gotoxy(2, 7);
    fprintf(stderr, "Output Bytes: (%7.1d)", out_cnt);
    bar_char((int)(out_cnt / (long)each_char), &xb2);
}

}

****
stuff(&fd2, oldcode, FALSE);
stuff(&fd2, NULL, CLOSE);
in_cnt++;
percent = (int)(100 - (100 * out_cnt) / in_cnt);
gotoxy(2, 10);
close(&fd1);

total_in_cnt += in_cnt;

if(percent >= min_percent && ((in_cnt - out_cnt) > (long)min_bytes))
{
    ip->status = COMPRESSED;
    dirty_bit = TRUE;
    settime(&dt, &ft);
    close(&fd2);
    unlink(tmp_name);
    rename(tmp_name, fname);
    total += (in_cnt - out_cnt);
    tot_compressed++;
    total_out_cnt += out_cnt;
    return(COMPRESSED);
}
else
{
    ip->status = LOW;
    dirty_bit = TRUE;
    close(&fd2);
    unlink(tmp_name);
    tot_hyased++;
    total_out_cnt += in_cnt;
    return(LOW);
}
}

```

the table of codes in this implementation of the LZW algorithm can contain as many as 4,096 different codes, finding whether a code is used or not can be a time-consuming effort unless done properly. In this case, a simple lookup would be too slow.

The hash-table algorithm used here simply takes a 20-bit number and tries to reduce it down to a 12-bit number via the routine `make_hash()`. The resulting hash code is looked up on a table. If the hash-code table entry is empty, then things are fine: the code-suffix pair (used by LZW to represent a byte sequence) does not exist in the table and can be safely added.

**PCMANAGE saves 35
to 50 percent of your
file's disk space—
and it only costs
you a few seconds
of decompression.**

However, if the hash code is found on the table, it may not be the one we care about: hash tables always have collisions between two members with the same hash code but with different member values. If the hash code does not match the member values, then a relative prime of 101 is added onto the index into the hash table and another comparison is made. The add-on value is prime relative to the size of the table: 101 is prime to 4,096 since they share none of the same factors. If they did, the possibility would exist for an endless loop. Eventually, the hash-code lookup will always result either in an empty slot on the table or in finding the proper match.

Using PCMANAGE can help you put a lot more on your hard disk. There's just no point in keeping files you need only rarely in a full-size form when you can save 35 to 50 percent of their disk space at the cost of a few seconds' decompression time. Remember, though, that even with these utilities, a hard disk will eventually fill up, so don't work so close to the limits that you can't expand a file when you need it! ■

Ross M. Greenberg is a frequent contributor to PC Magazine.

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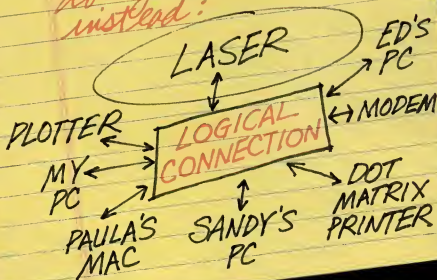
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by
Charles Petzold

Environments

Everything used to be so simple in the IBM-compatible world. Sigh. Five years ago we had *one* dominant operating system and *one* memory architecture. DOS was a single-tasking operating system that allowed programs to run in the then-huge 640K memory space defined by the 8088 microprocessor and the architecture of the IBM PC. That was our happy and consistent universe.

Then IBM introduced the first PC AT in 1984, and it became evident that some significant changes loomed just over the horizon. The AT was built around the Intel 80286 microprocessor. Unlike the 8088 in IBM's earlier machines, the 286 could operate in a "protected mode." Protected-mode operation gives programs access to 16MB of memory and is suitable for implementing real multitasking on the PC.

No sooner was the AT introduced than people began to speculate about "the new protected-mode operating system" that IBM or Microsoft would inevitably develop. At that time, no one could have guessed that the first version of this new operating system—which eventually evolved into OS/2—would not be released until three years later, in October 1987. Nor could anyone then have guessed that two years after its initial release, OS/2 would still be surrounded by controversy over its future.

STILL CONTROVERSIAL

Why the continuing controversy? It's not because we have come to accept the 640K barrier as satisfactory. Even in 1984, PC users were beginning to bump into the 640K memory barrier. And it's not because we don't want multitasking. Even in 1984, RAM-resident pop-up programs were becoming popular, and it was obvious that users wanted the ability to switch quickly among multiple applications.

The years since 1984, however, have seen a number of extensions to DOS that seemingly solve its limitations and hence (in the view of some) render OS/2 unnecessary. These DOS extensions include:

- various bank-switched memory schemes (called expanded memory) that allow specially coded DOS programs access to more than 640K of memory;
- DOS extenders that allow specially coded DOS programs to take advantage of extended memory on the 286 and 386 by running the program in protected mode;
- windowing environments, such as *Microsoft Windows* and *DESQview*, that support task switching and even multitasking for existing DOS applications and that provide an API (application program interface) for new applications written for the environment; and

- the Virtual-86 mode of the 386 microprocessor, which is used to support multitasking of existing DOS programs and to perform a number of memory management tricks, such as allowing RAM-resident programs to be loaded in extended memory.

What do I think about these extensions? To my mind, they are clearly nothing more than stop-gap measures. They may give DOS an extended lease on life, but they do not provide *long-term* solutions to the problems of DOS. The purpose of an operating system is to provide support for applications. Yet many of these DOS ex-

Windows and PM: Friendly Companions or Deadly Competitors?



ILLUSTRATION: SCOTT POLLACK

Environments

tensions shift that burden either to the application itself or to another system that runs on top of DOS.

And it's all so confusing! If you're running a program that uses a DOS extender, you want extended memory; if you're running a program that uses expanded memory, you want expanded memory. Or perhaps you need a device driver that converts extended memory to expanded memory. And if you're running *Windows/386* or *DESQview 386* as well, maybe it's best to divide your extra memory between extended and expanded. But how much of each is optimum?

Under OS/2, of course, memory is memory. It is much easier to configure a pure OS/2-based system than a DOS-based system that makes use of one or more of these DOS extensions. Still, these DOS extensions seem to provide hope to users that converting to a whole new operating system is simply not necessary.

MORE CONFUSION FROM MICROSOFT

As I write this column (in August 1989), there is a product coming down the pike that is guaranteed to add to this confusion. This product is *Microsoft Windows 3.0*, and it has everyone in a tizzy.

By the time you read this column, *Windows 3.0* may or may not be officially released to the public. Even at this stage, however, enough information is already available about the product—disclosed publicly by Microsoft and discussed in the trade weeklies—to make clear what the product will do.

Windows 3.0 will allow *Windows* applications to run in protected mode under DOS on either a 286- or a 386-based machine. For *Windows* programs, *Windows 3.0* breaks the 640K barrier without requiring the user to upgrade to a whole new operating system. The promise of this product has some people speculating that *Windows 3.0* will sound the death knell for OS/2. They ask why we need OS/2 for protected mode when *Windows 3.0* will give us protected mode under DOS.

Why is Microsoft adding to the confusion surrounding the future of PC operating systems? Will *Windows 3.0* really kill OS/2? I don't know if I can answer these questions, but I'll try at least to grapple with them.

I BELIEVE IN MAGIC

Program developers who received beta-test versions of *Windows 3.0* saw something new on the initial *Windows* logo screen: the words "I believe in magic."

It is magic of a sort that Microsoft has been able to bring protected mode to *Windows* while still running under DOS. If large *Windows* programs such as *PageMaker* or *Microsoft Excel* need more than 640K, *Windows 3.0* will give it to them. With sufficient memory, the programs will require fewer disk accesses and run faster.

Yet in a sense, Microsoft anticipated the *Windows 3.0* "magic." As I'll discuss more fully farther on in this column, Microsoft intended *Windows* to be part of "the future protected-mode operating sys-

If the magic
of *Windows 3.0* is
possible, then
it must be realized.

tem." Right from the start, then, the developers of *Windows* attempted to emulate protected-mode features within real mode.

Even the first retail release of *Windows 1.0*, when running on an 8088 machine, was capable of some very sophisticated memory management. *Windows 1.0* could move program code and data segments in memory, allow multiple instances of a program to share code, allow programs to share code and data located in dynamic link libraries, and discard program code segments from memory when not being used and later reload them from .EXE files when needed. If you're interested in the details, Chapter 8 of my book *Programming Windows* (Microsoft Press, 1988) discusses how *Windows* accomplishes these feats in real mode. The memory management implemented in *Windows* is truly one of its major achievements.

Many savvy *Windows* programmers, recognizing Microsoft's goals in the design of this protected-mode style of memory management, wrote *Windows* programs that carefully followed the *Windows* programming rules and did not attempt to do anything that would cause problems if the program were someday run in protected mode.

It thus became possible for Microsoft to consider actually running these *Windows* programs in protected mode. It's not quite as easy as it may sound. *Windows* still has to switch back to real mode when a *Windows* program makes a DOS function call, and running existing non-*Windows* DOS programs is still a problem. Indeed, even some *Windows* programs will require small changes to successfully run under *Windows 3.0*.

MICROSOFT'S STRATEGY

To those of us who long ago wrote off DOS and who see OS/2 as the salvation of the PC-compatible industry, the advent of *Windows 3.0* is indeed disturbing.

Microsoft is the largest software company in the personal computer industry. It is responsible for DOS (the most popular operating system in the world), for *Windows* (which currently outsells the Macintosh), and (in league with IBM) for OS/2. The personal computer industry looks to Microsoft for direction. Microsoft has been telling us that OS/2 is the future, yet with *Windows 3.0*, Microsoft suddenly looks like the Scarecrow in *The Wizard of Oz*, who points in one direction and then another.

Perhaps we're making the mistake here of overinterpreting Microsoft's strategy. There has been no indication that Microsoft is falling back from its support for OS/2. And certainly it can't be expected simply to abandon DOS and its existing DOS-based products for the sake of OS/2.

Windows has been a very successful product for Microsoft. If its software engineers know how to make *Windows* better by running *Windows* programs in protected mode, should Microsoft halt this work because the improved product will compete with OS/2? Imagine the uproar if it became public knowledge that the company was deliberately suppressing this newer technology!

Thus, if the magic of *Windows 3.0* is possible, then it must be realized. Microsoft has no real choice in the matter.

THE PROBLEM FOR DEVELOPERS

The introduction of a new operating system such as OS/2 poses the classic chicken-and-egg paradox. Users can't consider a new operating system until there are sufficient applications that run under it. Yet software developers are very reluctant to commit major resources to writing commercial applications for a new operating system until they are sure that there will be

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enough users of the operating system to buy the applications.

The creators of a new operating system (or an operating environment that runs on top of an operating system) must persuade developers that the operating system will be a success. Microsoft did this with *Windows*, and that's why *Windows* is a success. IBM failed to do so with *TopView*, and *TopView* died.

Microsoft now has two different graphical user interfaces—*Windows* and the OS/2 Presentation Manager. Program developers interested in writing for a graphical interface on the PC must make a choice. They can program for *Windows*, for PM, or—separately—for both.

The last alternative sounds like the best, but it's a difficult one. While *Windows* and PM are similar in overall structure and the user interface, they are different in the details of the application program interface. Converting a *Windows* program to the Presentation Manager (or vice versa) is not an easy task.

Prior to *Windows 3.0*, the choice was clear: for immediate payoff in the market, go with *Windows*. For the long term, it's the Presentation Manager. For very large programs, the Presentation Manager was the only possibility.

But that's changed now. *Windows 3.0* will give programmers the memory they need for large sophisticated applications, and *Windows* has the established user base to provide an immediate payoff. Indeed, it appears that some software manufacturers who previously had ignored *Windows* and focused instead on PM are now reevaluating their original decision in the light of *Windows 3.0*.

It wasn't supposed to be like this. Back in the early days of *Windows*, Microsoft never intended to put itself in the unenviable situation of supporting two different graphical user interfaces.

BALLMER'S PLEDGE

In June 1986, I attended a two-day *Windows* Development Seminar in New York—part of Microsoft's effort to persuade developers to write for *Windows*. The first speaker at that seminar was Steve Ballmer, the vice president of Microsoft's System Software Group. Ballmer outlined the benefits of *Windows* and emphasized Microsoft's commitment to the product.

Ballmer went on to discuss the long-term future of *Windows*, which looked rosy indeed. Here, transcribed from cassette tapes provided by Microsoft, is what he said on that subject:

"I think it's fairly well known, from [the] press, etc., that Microsoft is working on a future version of DOS that supports the 286 in its so-called protected mode, where you have a full 16MB of address space and you get access to the memory

management features of the 286. We have committed to make sure that the *Windows* API exists in a completely compatible fashion between real mode, or today's *Windows*, and this new protected-mode OS [operating system]. We've also told people, and I'll tell you again today, that it'll be a fairly transparent process to take an application that runs on *Windows* today on top of DOS 3.0 and to move it to a new version of *Windows* that runs on top of this

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new 286 protected-mode version of DOS."

This statement had a big impact on me, as I'm sure it had on other programmers. I used to tell people that by programming for the Windows API, I was also programming for the future protected-mode operating system.

The "protected-mode version of DOS" turned out to be OS/2, officially announced by IBM and Microsoft less than a year after this seminar. Alas, however, things did not turn out quite as Ballmer had promised. Not a single function call in Windows was preserved in the Presentation Manager API. The "fairly transparent process" of which Ballmer spoke has turned out to be a major headache for programmers.

Imagine the situation if what Ballmer said had actually been realized. Imagine that you could take existing Windows programs and run them under OS/2. Imagine that these Windows programs would now suddenly have access to the 16-megabyte protected-mode memory space. If this scenario had come to pass, OS/2 would already be a success. Many Windows users would make the jump to OS/2 just to gain access to the extra memory.

WHY THE DIFFERENT API SETS?

Surely it was to Microsoft's advantage to preserve the Windows API in OS/2. What happened to prevent it?

No one can be sure, of course, for the decisions were reached in top-secret negotiations between IBM and Microsoft. But the consensus of speculation (and I must emphasize that it is speculation) goes something like this:

It was obvious both to IBM and to Microsoft that a graphical user interface was necessary for the new protected-mode operating system. IBM wanted to design their own GUI. Microsoft thought that this was unnecessary because Windows 1.0 had already been developed and was headed for success in the DOS world. Although Microsoft convinced IBM to use Windows in the new operating system, there was a little catch: IBM wanted some changes.

Some of these changes were cosmetic. They involved the Windows user interface and had little impact on the API. Windows 1.0 had tiled windows, and IBM wanted overlapping windows, for example. IBM

also wanted some more subtle changes in the menu interface. Many of these changes were incorporated into Windows 2.0, and in retrospect, we can see that product as a prototype for the user interface of the OS/2 Presentation Manager.

Other changes that IBM wanted had a more serious impact, however: IBM wanted to use a derivative of its mainframe GDDM (Graphical Data Display Manager) graphics system in the Presentation Manager. This became known as GPI (Graphics Programming Interface), which replaced the Windows GDI (Graphics Device Interface).

IBM was also at this time committed to SAA (Systems Application Architecture), a set of guidelines designed to establish consistency among its mainframes, minicomputers, and PCs. Part of SAA involves a consistent API function call format, and

**The result of the
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Presentation Manager
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rules about the parameters to these functions. By this time, the changes were so severe that Microsoft apparently decided to revamp other aspects of Windows in its conversion to the Presentation Manager.

To Windows programmers like me, who were expecting to see a fairly straightforward path from Windows to OS/2, the Presentation Manager API came as a real shock. It was as if we had crossed a border into another country. Everything was still recognizable, but the language was completely different.

THE PROGRAMMER'S AND USER'S VIEWS
The result of the collaboration between IBM and Microsoft in creating the OS/2

Presentation Manager was a healthy one because PM represents the best that IBM and Microsoft have to offer. It was truly a synergistic enterprise.

I have found no programmer who will claim that the Presentation Manager API is not significantly superior to the Windows API. The IBM graphics system is definitely superior; the windowing functions are cleaner, more orthogonal, more versatile than their Windows counterparts. The API has been largely stripped of its reliance on the segmented memory architecture of the 8088 and 80286 microprocessors.

It's easy for program developers to see the advantages of the Presentation Manager over Windows, and of OS/2 over DOS. Programmers can recognize the value of the better graphics interface, the use of multiple threads, and the various interprocess communication mechanisms. Yet these features are not so evident to users.

What is evident to users is the larger memory space, because this is quantifiable. It doesn't take much in the way of technical ability to recognize a difference between 640 kilobytes and 16MB. Both OS/2 and Windows 3.0 provide this 16MB address space, so to users there seems to be little reason to replace DOS with OS/2. And if program developers see that Windows users don't feel a need to move to OS/2, then they will concentrate on writing Windows applications rather than PM applications.

What the users can't see and so fail to understand is that the significantly better OS/2 and Presentation Manager APIs would give developers much more powerful tools with which to create substantially better applications than will ever be possible under Windows 3.0, DOS, or any of the extensions mentioned previously.

SOME GOOD NEWS

I realize that I've been painting a bleak picture for OS/2 and the Presentation Manager. OS/2 had been experiencing a sluggish start even before the news about Windows 3.0 began to emanate from Microsoft. Windows 3.0 seems to make things worse, but let's see if there's a silver lining in these ominous storm clouds.

First, perhaps Microsoft's strategy is not as perverse as it may seem. When Windows 3.0 is released and can run Windows applications in protected mode, Windows users are going to want more memory. A good machine for running Windows 3.0 comprises a 386 or a fast 286 microprocessor, a large hard disk, a medium-resolution

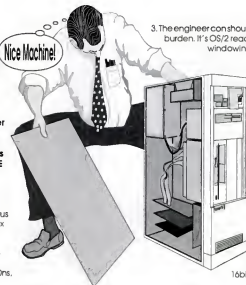
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color display such as the VGA, and several megabytes of memory.

And guess what? These are precisely the hardware requirements for OS/2! Given that *Windows* applications and OS/2 Presentation Manager applications have the same user interface, it will be a relatively transparent process for users to move from a DOS and *Windows* 3.0 environment to an OS/2 environment.

Secondly, is it really so bad that developers may turn away from the Presentation Manager and concentrate on writing *Windows* 3.0 applications instead? Not in the long term. Learning to program for any graphical interface is a big job for programmers, and much of what they must

Much of what programmers must learn to write for *Windows* can be carried over into writing for the PM.

learn to write for *Windows* can be carried over into writing for the Presentation Manager.

Moreover, Micrographx (the creators of several very good *Windows* programs) has been working on a product called *Mirrors* that will help *Windows* programmers convert their programs to the Presentation Manager. It involves recompiling the *Windows* program, using an OS/2 dynamic link library to convert the *Windows* function calls to PM function calls.

It's also likely that in the next couple of years we'll see adequate object-oriented programming tools that will let us write single programs that can be compiled for multiple graphical interfaces. This also would help software manufacturers write programs that run under both *Windows* and the Presentation Manager.

Third, there are enhancements to OS/2 to be expected in the next year. By the time you read this column, OS/2 1.2 (which includes the new High Performance File System, or HPFS) should be close to being

released, if it has not been already. Judging from some preliminary benchmarks, HPFS will have significant speed performances over the DOS file system.

Finally, OS/2 2.0, which takes advantage of the 386 microprocessor, is expected in mid-1990 or thereabouts. This will give OS/2 applications the use of 32-bit registers and a 32-bit flat address space, as well as the ability to run multiple DOS sessions using Virtual-86 mode.

BALLMER'S PLEDGE REDEEMED?

Consider the following for a moment: With the advent of *Windows* 3.0, Microsoft is emphasizing to programmers the importance of fixing their existing *Windows* applications so they don't violate any protected-mode rules and will run without problems under the new environment. Micrographx has demonstrated that it is possible to create an OS/2 dynamic link library that converts *Windows* function calls to Presentation Manager function calls.

Wouldn't it make sense for Microsoft to include such a dynamic link library with OS/2 2.0, allowing *Windows* programs to run in the Presentation Manager session alongside PM programs?

In fact, there have already been rumors and speculation about this possibility in the trade weeklies. It's an enticing prospect. We know now that OS/2 2.0 will be able to run existing DOS programs, existing OS/2 kernel and PM programs written for the 16-bit system, and new OS/2 programs written for the 32-bit system. The additional capability of running *Windows* 3.0 programs would undoubtedly be a big plus.

And that is how *Windows* and the Presentation Manager could become true companions rather than competitors. We'd have one system that would run both types of applications. Steve Ballmer's 1986 pledge to *Windows* programmers would finally be realized, albeit four years later.

I can only hope that Microsoft will be able to carry it off. OS/2 and the Presentation Manager (particularly when taking advantage of the 386) are obviously more tuned to the future than DOS and *Windows*—even *Windows* 3.0. But DOS and *Windows* have achieved such a heavy penetration that they cannot simply be abandoned. They must be incorporated into OS/2 in a way that is nearly seamless to users. It is only when users can finally see and understand the real benefits of OS/2 that the PC industry will be able to take the next legitimate step into the future. ■

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CIRCLE 263 ON READER SERVICE CARD

by
Ray Duncan

Power Programming

Arithmetic Routines For Your Computer Programs, Part 3

The classical arithmetic algorithms that underlie the longhand procedures we all use for integer addition, subtraction, multiplication, and division have been well understood for hundreds of years. Indeed, the term *algorithm* originally referred only to the formalized procedures for these arithmetic operations and is actually a corruption of the name of renowned Arab mathematician al-Khwārizmī.

The classical algorithms are important not only to schoolchildren but to programmers and computer designers as well. The algorithms are the foundation for hardware adders, multipliers, and dividers, and for the design of software routines that can carry out arithmetic operations that are not supported in hardware.

Schoolchildren are typically taught the *how* without the *why* when it comes to basic arithmetic. I found it quite enlightening to look closely at the classical algorithms (particularly for multiplication and division) and to realize the extent to which I had been basing these longhand procedures on faith rather than understanding.

The aspiring programmer's ultimate resource on the classical algorithms (and on a mind-boggling assortment of other topics as well) is Donald Knuth's *The Art of Computer Programming*. Knuth combines a gift for clear writing with a depth of mathematical insight and a breadth of knowledge and experience that have few parallels in these days of superspecialized professors. Dr. Knuth needs no favorable reviews from me, of course; although his three volumes (so far) may at first appear intimidating, it is a truism to say that they should be on the bookshelves of all but the most casual programmer.

Knuth's discussion of the classical algorithms appears on pages 229–45 of volume 2, *Seminumerical Algorithms*. Unfortunately, however, his program examples are rendered in MIX, the assembly language of a hypothetical CPU for which simulators exist only in the halls of academe. Accordingly, in the last installment of this column, I presented high-level,

■ Implementations of the classical algorithms for multiplication and division that you can use in your own programs round out this series on arithmetic operations.

radix-independent, pseudo-C translations of Knuth's example routines for addition, subtraction, and multiplication. We then used this pseudo-code as a guide for the implementation of corresponding assembly language subroutines.

I don't plan to take this approach for division, however, because the classical algorithm for radix-independent division is rather complex and subtle. If you recall long division as one of the major sore points of your first few years of grade school—something that caused significantly more mental anguish than addition, subtraction, and multiplication—there is a good reason for this. Long division requires normalizations, groupings, and “trial divides” that do not reduce readily into a simple, easily understood piece of radix-independent pseudo-C code.

Luckily, however, there is a solution that will suffice nicely for the purposes of this column. When working in binary (radix = 2), the classical division algorithm degenerates to a considerably simpler form that we typically see implemented in a shift-and-subtract loop. The multiple trial

divides that are often needed for each forward step in the generalized form of the algorithm—not to mention the logic necessary to pick trial divisors intelligently—go away completely in binary. Similarly, when used for binary multiplication, the classical algorithm can be simplified into a short and sweet shift-and-add loop.

“Ah yes,” I can almost hear you saying, “the good old shift-and-add and shift-and-subtract methods of multiplication and division.” Why—even at this considerable distance—can I almost hear you saying this? Because of all the times I’ve muttered it to myself, of course! We all are familiar with these types of routines, and we feel instinctively that we understand how they work—or could understand easily if we only bothered to try. We have day-to-day experience with using a left shift for a fast multiply by 2 and a right shift for a fast divide by 2. We’ve all taken the commonly used multiply-by-10 shortcut that relies on a couple of shifts and an add.

But few of us are actually ever called upon to write one of these multiplication or division routines, and in practice they are not quite as “obvious” as we fondly imagine. On the other hand, there is certainly nothing magical about such routines; they turn out to be quite straightforward when given the usual attention to detail.

In this column, I’ll provide cookbook methods for writing multiplication and division routines that will serve you well on any reasonable CPU (the nasty CPUs that use 1s’-complement arithmetic or lack a carry flag are better avoided than con-

Power Programming

quired), and then I'll illustrate these methods with working code.

RECIPE FOR SHIFT-AND-ADD MULTIPLY

The following procedure assumes that you are multiplying two arguments (sometimes called the multiplier and multiplicand) that are the same length (in bytes) to obtain a product that is twice the length of either argument. The arguments and the product are further assumed to be unsigned; handling arithmetic signs and checking for zero arguments is best done in a "shell" routine external to the fundamental multiplication procedure. This allows routines that need maximum speed and that have control over their arguments to call the unsigned routine directly, achieving best performance. Lastly, it is assumed that your CPU has a carry flag that is under direct program control, and that it has both right and left shift instructions that work together with the carry flag, allowing you to remove a bit from one byte and insert it in another.

Given these assumptions, the steps in the recipe are as follows:

- (1) Initialize the high half of the buffer that will receive the product to 0. (The low half will be discarded by shifting, so its original value is unimportant.)
- (2) Initialize the loop counter to 8 times the length of each argument (in bytes); this is the number of binary "digits" (bits) in the multiplier that must be tested.
- (3) Clear the carry flag.
- (4) Logical right-shift the buffer that contains the forming product by one bit position; the value that is in the carry flag becomes the new most significant bit of the product.
- (5) Logical right-shift the buffer that contains the second argument (the multiplier) by one position; the "lost" bit shifted out is saved in the carry flag.
- (6) If the carry flag is clear (that is, if the bit shifted out of the multiplier was 0), go to step 8.
- (7) If the carry flag is set (that is, if the bit shifted out of the multiplier was 1), add the first argument (the multiplicand) to the high half of the forming product. Any overflow of this addition is saved in the carry flag.
- (8) Decrement the loop counter, preserving the carry flag; if the loop counter is nonzero, go to step 4 and continue.

MPMUL2.ASM

1 of 2

PC
Magazine

```
title MPMUL2.ASM Multiple-Precision Unsigned Multiply
page 55,132

; MPMUL2.ASM Multiple-Precision Unsigned Multiply
; for Intel 8086, 8088, 8286, and
; 80386 in real mode/16-bit protected mode.
; This version uses "shift and add" method.

; Copyright (C) 1989 Ziff Communications Co.
; PC Magazine - Ray Duncan

; Call with: DS:SI = address of source operand
;            ES:DI = address of destination operand
;            CX = operand length in bytes

; Assumes direction flag is clear at entry
; Assumes DS = ES <= 86
; Assumes 8 < CX <= 255

; Returns: ES:DI = address of product

; NOTE: Buffer for destination operand must be
; twice as long as the actual operand, because
; it will receive a double-precision result.

; Destroys: AX (other registers preserved)

_TEXT segment word public 'CODE'

assume cs:_TEXT

mpmul2 public mpmul2
proc near

    push bx ; save registers
    push cx
    push dx
    push bp

    push di ; save addr of dest argument
    mov dx,cx ; save bytes/operand

    add di,cx ; find address of high half
    mov bp,di ; of product, save it in BP

    xor al,al ; initialize high half
    rep stosb ; forming product to zero

    pop di ; retrieve addr of dest arg

    mov cx,dx ; CX = bits per argument + 1
    shl cx,1
    shl cx,1
    inc cx

    cld ; initialize carry

mpmul2: pushf ; save carry flag
        mov bx,dx
        shl bx,1
        dec bx ; BX = bytes in product - 1
        popf ; restore carry flag

mpmul2: ror byte ptr [di+bx],1 ; shift forming product and
        dec bx ; dest operand right 1 bit
        jns mpmul22 ; loop while BX >= 0

        jmp mpmul24 ; jump if bit shifted out = 0

        ; bit shifted out = 1
        xchg bp,di ; DI = high half of product
        push cx ; save bit counter
        mov dx,cx ; CX = bytes per argument
        xor bx,bx ; init index (also clears carry)

mpmul23: mov [si+bx],al ; add source argument to high
        adc [di+bx],al ; half of forming product
```

Figure 1: A general-purpose unsigned multiplication routine for multiple-precision integers. This version uses a binary shift-and-add approach that does not exploit the CPU's native hardware multiply. Compare with the MPMUL1.ASM listing published in our previous issue, which carries out multiplication in a byte-wise fashion using the CPU's MUL instruction.

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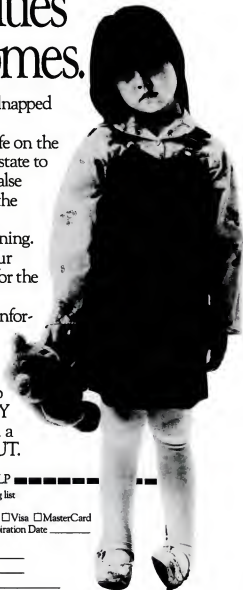
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To understand what's going on here, just think back to the longhand technique for multiplying decimal numbers. Each digit of the multiplicand is multiplied by each of the digits of the multiplier to obtain a set of partial products. After appropriate shifting, the partial products are added together to form the final product.

In binary multiplication, each "digit" of the multiplier can only be a 0 or a 1, so each "partial product" that needs to be accumulated is either 0 or the appropriately shifted value of the multiplicand. The rest is just trickery to make everything end up in the correct position.

SHIFT-AND-SUBTRACT DIVIDE

In the next procedure, the assumption is that you are dividing an unsigned dividend by an unsigned divisor to get an unsigned quotient and an unsigned remainder. The dividend is further assumed to be twice the length (in bytes) of the divisor; both re-

Handling signs, zero divisors, and other odd conditions outside the core unsigned division routine has advantages.

mainder and quotient are the same length as the divisor.

Again, signs, zero divisors, overflow, and other odd conditions should be handled outside the core unsigned division routine; this allows routines that require maximum speed and that have control over their arguments to call the unsigned routine directly. Finally, it is assumed that the characteristics (shifts and carry-flag control) demanded of the CPU for the shift-and-add multiplication routine also apply for the shift-and-subtract divide routine. The steps in the recipe become:

(1) Set the loop counter to the value that is 8 times the length of the divisor (in bytes); this is the number of bits of quotient and remainder that need to be generated. The initial value in the buffer that will receive the

```

MPMUL2.ASM                                     2 of 2

        inc     bx
        loop    mpmul23

        pop     cx
        xchg    bp,di                        ; restore bit counter
                                           ; restore dest operand pointer

mpmul24: loop    mpmul21                    ; loop until all bits processed

        pop     bp
        pop     dx
        pop     cx
        pop     bx
        ret                                     ; back to caller

mpmul2   endp
TEXT    ends
        end
    
```

```

MPDIV.ASM                                     1 of 2

        title   MPDIV.ASM Multiple-Precision Unsigned Divide
        page    55,132

; MPDIV.ASM   Multiple-Precision Unsigned Divide
;             using "shift-and-subtract" method
;             for Intel 8086, 8088, 80286, and
;             80386 in real mode/16-bit protected mode.

; Copyright (C) 1989 Siff Communications Co.
; PC Magazine • Ray Duncan

; Call with:  DS:SI = address of divisor
;             ES:DI = address of dividend
;             CX = divisor length in bytes
;             (dividend length = 2 * divisor length)

;           Assumes direction flag is clear at entry
;           Assumes DS = ES <> SS
;           Assumes 0 < CX <= 255

; Returns:   ES:DI = address of quotient
;            DS:SI = address of remainder

;           NOTE: Dividend is assumed to be twice as long
;           as the divisor. Returned remainder and quotient
;           are same size as divisor.

; Destroys:  AX (other registers preserved)

TEXT    segment word public 'CODE'
        assume  cs:_TEXT

        public mpdiv
mpdiv    proc    near

        push    bx
        push    cx
        push    dx
        push    si
        push    di
        push    bp

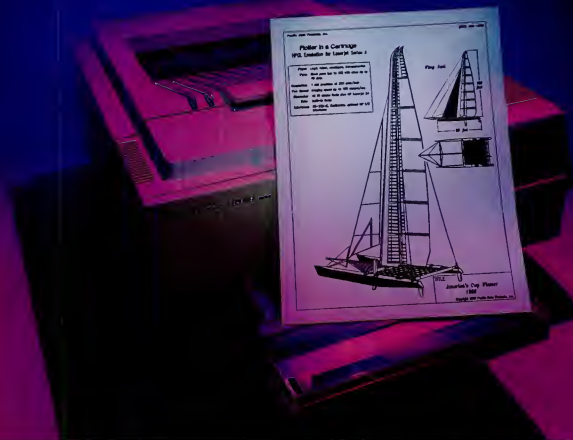
        mov     dx,cx                        ; save divisor length in DX

        mov     bp,cx                        ; BP will be outer loop
        shl     bp,1                          ; counter, set it to number
        shl     bp,1                          ; of bits in divisor

        cld                                     ; initially clear carry
    
```

Figure 2: A general-purpose unsigned division routine for multiple-precision integers. It carries out the operation in binary using a shift-and-subtract loop.

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Power Programming

MPDIV.ASM

2 of 2

```

mpdiv1: push    di                ; save pointer to dividend
        mov     cx,dx            ; CX = bytes in dividend

mpdiv2: rcl     word ptr [di],1    ; shift carry flag into
        inc     di              ; low bit of quotient
        inc     di              ; shift high bit of dividend
        loop    mpdiv2           ; into carry flag

        pop     di              ; restore pointer to dividend
        jnc     mpdiv5          ; jump if high bit was clear

mpdiv3: push    ei              ; save pointer to divisor
        push    di              ; save pointer to dividend

        add     di,dx            ; DI = addr high half of dividend
        mov     cx,dx            ; CX = bytes in divisor
        cld                     ; initially clear carry

mpdiv4: mov     al,[si]          ; subtract divisor from high
        ebb     [di],al         ; half of dividend
        inc     ei
        inc     di
        loop    mpdiv4

        pop     di              ; restore pointer to dividend
        pop     ei              ; restore pointer to divisor

        etc                    ; shift hit=1 into quotient
        dec     bp              ; all bits of answer generated?
        jnz     mpdiv1          ; no, loop
        jmp     mpdiv7          ; yes, go clean up and exit

mpdiv5: push    ei              ; save pointer to divisor
        push    di              ; save pointer to dividend

        add     di,dx            ; point to high half of dividend
        mov     cx,dx            ; CX = bytes in divisor
        cld                     ; initially clear carry

mpdiv6: mov     al,[di]          ; high half of dividend > divisor?
        ebb     al,[si]
        inc     ei
        inc     di
        loop    mpdiv6

        pop     di              ; restore pointer to dividend
        pop     ei              ; restore pointer to divisor
        jnc     mpdiv3          ; jump, high dividend > divisor

        cld                     ; shift hit=0 into quotient
        dec     bp              ; all bits of answer generated?
        jnz     mpdiv1          ; no, loop again

mpdiv7: mov     cx,dx            ; CX = bytes in quotient

mpdiv8: rcl     byte ptr [di],1    ; bring final bit into quotient
        inc     di
        loop    mpdiv8

        xchg    ei,di           ; copy remainder to final address
        mov     cx,dx
        rep movsb

        pop     bp              ; restore registers
        pop     di
        pop     ei
        pop     dx
        pop     cx
        pop     bx
        ret                     ; back to caller

mpdiv   endp
_TEXT   ends
        end
    
```

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Power Programming

quotient is unimportant because it will be discarded by shifting during the procedure.

(2) Clear the carry flag.

(3) Left-shift the quotient by one bit position; the previous value of the carry flag is inserted into the quotient as the new least significant bit.

(4) Left-shift the dividend by one bit position; the bit shifted out is saved in the carry flag.

(5) If the carry flag is clear, go to step 7.

(6) Subtract the divisor from the upper half

**Shifting is a shortcut
to inspecting groups
of the dividend's
digits equal in length
to the divisor.**

of the dividend. Set the carry flag and go to step 8.

(7) If the upper half of the dividend is larger than the divisor, go to step 6; otherwise, clear the carry flag and go to step 8.

(8) Decrement the loop counter, preserving the state of the carry flag; if the loop counter is nonzero, go to step 3.

(9) Left-shift the quotient by one bit position, bringing the carry flag into the quotient as the final least significant bit. (Moving this last shift outside the main loop is not really necessary, but it allows the use of a slightly more efficient control structure.) The remainder is whatever is left in the high half of the dividend.

Again, when attempting to understand what is going on in this procedure, it is helpful to draw analogies to longhand decimal division. The important distinction, however, is that trial divides are not necessary when we choose to view each bit as a single digit; either the divisor can fit into the portion of the dividend we are looking at or it can't. We use shifting as a convenient shortcut to inspecting groups of the dividend's digits that are the same length as the divisor. The rest is just bookkeeping and positioning of the results.

MPDIV.ASM

1 of 2



```

title MPDIV.ASM Multiple-Precision Signed Divide
page 35,132

; MPDIV.ASM
; Multiple-Precision Signed Division
; for Intel 8086, 8088, 80286, and
; 80386 in real mode/16-bit protected mode.
; Requires MPNEG.ASM (multiple-precision
; 2's complement) and MPDIV.ASM (multiple-
; precision unsigned integer divide).
;
; Copyright (C) 1989 Ziff Communications Co.
; PC Magazine Ray Duncan
;
; Call with: DS:SI = address of divisor
; ES:DI = address of dividend
; CX = divisor length in bytes
; [dividend length = 2 * divisor length]
;
; Assumes direction flag is clear at entry
; Assumes DS = ES <> SS
; Assumes P < CX <= 255
;
; Returns: ES:DI = address of quotient
; DS:SI = address of remainder
;
; NOTE: Dividend is assumed to be twice as long
; as the divisor. Returned remainder and quotient
; are same size as divisor.
;
; The sign of the quotient is positive if the signs
; signs of the dividend and divisor are the same;
; negative if they are different. The sign of the
; remainder is the same as the sign of the dividend.
;
; Destroys: AX [other registers preserved]

_TEXT segment word public 'CODE'

extrn mpdiv:near
extrn mpneg:near

assume cs:_TEXT

mpdiv public mpdiv:near
proc
push bx ; save registers

mov bx,cx ; get Exclusive-OR of
mov el,[si+bx-1] ; signs of operands
add bx,bx
xor el,[di+bx-1] ; save sign of result
pushf

mov al,[di+bx-1] ; test sign of dividend
or al,el
pushf ; save sign of remainder

jns mpdiv1 ; jump if dividend positive

push si ; save pointer to divisor
push cx ; save length of divisor

mov si,di ; point to dividend
add cx,cx ; calc length of dividend
call mpneg ; flip sign of dividend

pop cx ; restore length of divisor
pop si ; restore address of divisor

mpdiv1: mov bx,cx ; check if divisor negative
test byte ptr [si+bx-1],80h
jz mpdiv2 ; jump, divisor is positive

push di ; save pointer to dividend
call mpneg ; flip sign of divisor
pop di ; restore pointer to dividend

mpdiv2: call mpdiv ; perform unsigned divide

popf ; retrieve sign of remainder
jns mpdiv3 ; jump, remainder is positive

```

Figure 3: A general-purpose signed division routine for multiple-precision integers. This routine requires MPDIV.ASM (Figure 2) and MPNEG.ASM.

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Speed	✓ up to 10 ppm	up to 8 ppm
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Paper-handling options	✓ 500 sheets, 75 envelopes	15 envelopes*
Collates letters/envelopes	✓ yes**	no
Plotter emulation	✓ standard	optional
Resident fonts	✓ 10	6
Font card size**	✓ credit card	"8-track" cassette
Standard weight	✓ 33 lbs.	50 lbs.
Parts***	✓ 400	1000
Dots per inch	300 x 300	300 x 300
Printer emulation	✓ IBM, HP compatible	HP compatible
Printer engine	IBM	Canon
List price	✓ \$2,595	\$2,695

*HP envelope tray replaces standard paper tray **With paper-handling options ***Approximate

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Power Programming

MPIDIV.ASM

2 of 2

```

push    di                ; save pointer to quotient
call    mpneg             ; flip sign of remainder
pop     di                ; restore pointer to quotient

mpid3:  popf              ; retrieve sign of result
jns     mpid4             ; jump, result is positive

push    si                ; save pointer to remainder
mov     si,di             ; point to quotient
call    mpneg             ; flip sign of quotient
pop     si                ; restore pointer to remainder

mpid4:  pop     bx         ; restore register
ret                     ; back to caller

mpidiv  endp

_TEXT  ends

end
    
```

MULTIPLE-PRECISION ROUTINES

Figures 1 through 3, plus MPIMUL.ASM and MPNEG.ASM presented last time, contain the source code for assembly language procedures that illustrate what we've been discussing here and that round out our battery of multiple-precision arithmetic routines. The calling procedures and results of each routine are documented in the listings.

MPMUL2.ASM, shown in Figure 1, is the unsigned multiple-precision-integer multiplication routine that uses the shift-and-add technique. You may find it instructive to compare this code with the MPMUL1.ASM published here in the previous issue. The latter used the CPU's native 8-bit-by-8-bit multiply, and you may wish to run some timing comparisons of the two routines. When running benchmark tests, remember that there are drastic differences in the cost of a hardware multiply as you progress from the 8086/88 to the 80386 and 80486.

MPIMUL.ASM is the signed multiple-precision multiply routine. It checks the signs of the arguments to determine the sign of the eventual result, changes arguments from negative to positive if necessary (using MPNEG.ASM), then calls MPMUL2.ASM to do the hard work.

MPDIV.ASM, shown in Figure 2, is the unsigned multiple-precision divide routine that implements the shift-and-subtract technique described earlier. If you're feeling spunky, read Knuth (volume 2, pages 237-38) and code a new version of this routine that exploits your CPU's native DIV instruction.

MPIDIV.ASM, shown in Figure 3, is the signed multiple-precision divide routine that checks and changes signs of arguments and results, much in the same way as MPIMUL.ASM. It calls MPNEG.ASM and MPDIV.ASM. Note that calls to MPIDIV.ASM should be avoided if you know that the sign of your arguments and results is not important (for example, when manipulating addresses), since MPIDIV is slower than MPDIV.

I've tried to make these routines reasonably efficient, though to keep them from diverging too far from the recipes presented above, I have forgone a number of optimizations that I would use in a production program. Once you're sure you understand the code, you can entertain yourself for hours by tuning it up further. Just beware of introducing machine instructions that affect the carry flag!

I've also written two interactive demonstration programs, TRYMPMUL.ASM and TRYMPDIV.ASM, that will facilitate your experiments. These programs prompt you for arguments, call the appropriate multiply or divide routine, then display the results. Because of their length, TRYMPMUL and TRYMPDIV are not printed here, but both are available for downloading from PC MagNet.

THE IN-BOX

Please send your questions, comments, and suggestions to me at any of the following e-mail addresses:
PC MagNet: 72241,52
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by
Douglas Cobb
and Steven Cobb

Spreadsheet Clinic

CHANGING COLUMN WIDTHS

I often need to change the widths of adjacent columns while working with a 1-2-3 worksheet. For example, I might need to set the width of column A to 25, column B to 17, column C to 5, and column D to 10. To do this, I insert a new row into the worksheet and enter the new width for each column into the cells of that row. Then I move the cell pointer to the leftmost cell that contains a width value and invoke the macro shown in Figure 1.

The first statement in this macro checks to see if the highlighted cell contains a value less than 1, a label, or nothing. In any of these cases, the {If} statement will be true and 1-2-3 will end the macro execution.

The second statement checks if the value in the current cell is greater than 240 (the maximum width of a cell). If it is, 1-2-3 will cancel the execution of the macro. However, if the current cell contains a value from 1 to 240, inclusive, 1-2-3 will execute /Worksheet Column Set-Width and then the statement in cell B4.

The {If} command at the beginning of this statement checks to see if the value in the current cell is greater than the width of the column that contains this cell. If it is, 1-2-3 hits the Right Arrow key as many times as required to increase the width of the column to equal the value in the current cell, then hits Enter. If the value in the current cell is less than the width of the column that contains it, 1-2-3 will press the Left Arrow key as many times as required to decrease the width of the column to equal the value in this cell, then hit Enter. In either case, 1-2-3 will then move the cell pointer one cell to the right and restart the macro.

Let's suppose you want to change the column widths of A, B, and C from 9 spaces each to 12, 5, and 20 spaces, respectively. First insert a new, blank row into the worksheet—say, between rows 9 and 10. Next, enter the values 12, 5, and 20 into cells A10, B10, and C10, respectively, and make sure that cell D10 is blank. Move the cell pointer to cell A10 and invoke the macro by pressing Alt-W.

■ **CHANGING COLUMN WIDTHS:** Here's a quick and easy way to set various widths for multiple columns in a 1-2-3 worksheet.

■ **QUICK CASE CONVERSIONS:** Change the labels in your worksheets to uppercase, lowercase, or proper form instantly.

Since cell A10 contains a value not less than 1 or greater than 240, 1-2-3 will issue the /Worksheet Column Set-Width command. And since the current cell value (12) is greater than the width of its column (9), 1-2-3 hits the Right Arrow key three times, and then hits Enter. This expands the width of column A to 12 spaces. At this point,

1-2-3 moves the cell pointer to cell B10 and restarts the macro, repeating this process for cells B10 and C10.

Finally, 1-2-3 moves the cell pointer to cell D10 and restarts the macro a fourth time. Since this cell is blank, the {If} statement in cell B1 will be false. So 1-2-3 ends execution of the macro. Use the /Worksheet Delete Row command to delete the temporary row from the worksheet.

Jim Strahan
Costa Mesa, California



This technique makes it easy to alter the width of two or more columns in a 1-2-3 worksheet. However, the columns don't need to be adjacent to one another. Simply enter

@CELL("width",x1..x1)

where x is the letter (or letters) that identify the column, into the cell (in the new row) of the column whose size remains the same. Since this function returns the cur-

COLUMN WIDTH MACRO					COMPLETE LISTING			
	A	B	C	D	E	F	G	H
1	/W	{If @CELLpointer("contents")<1}{Quit}						
2		{If @CELLpointer("contents")>240}{Quit}						
3		/Wcs						
4		{If @CELLpointer("contents")>@CELLpointer("width")}						
		{Right @CELLpointer("contents")-@CELLpointer("width")}						
5		{Left @CELLpointer("contents")-@CELLpointer("width")}						
6	CONTINUE	{Right}						
7		{Branch /W}						
8								

Figure 1: To alter the width of multiple columns, simply enter the new values, invoke this macro, and your worksheet's columns will automatically be adjusted.

MODIFIED COLUMN WIDTH MACRO					COMPLETE LISTING			
	A	B	C	D	E	F	G	H
1	/W	{If @CELLpointer("contents")<1}{Quit}						
2		{If @CELLpointer("contents")>240}{Quit}						
3		{Recalc NEXT}						
4	NEXT	/Wcs						
5		{Right}						
6		{Branch /W}						
7								

Figure 2: This macro is a streamlined version of the one shown in Figure 1.

Spreadsheet Clinic

rent width of the column, the macro will keep the current width.

You can simplify Strahan's macro, as shown in Figure 2. The third statement in this macro commands 1-2-3 to recalculate the string formula

```
B4: +=wcb&@STRING(@CELLPOINTER
('contents'),0)&""
```

in cell B4, and returns the statement

```
/wcbwidth"
```

where *width* is the value in the current cell. Unlike the original macro, this one adjusts the width of each column by typing rather than pointing.

QUICK CASE CONVERSIONS

In my work with 1-2-3, I often adapt worksheets created by others. Unfortunately, different 1-2-3 users have different styles: some enter labels in all uppercase letters, some in all lowercase letters, and some in initial-capitalization form.

I'm sending you a copy of a macro I developed that changes the case of the labels to suit a user's preference. When invoked, 1-2-3 presents a menu with the choices Upper, Lower, and Proper. After making a selection, it replaces all the labels in the range you specify with the form you selected—without affecting any values, formulas, or functions in the range.

Robert Allen
Johnson City, Tennessee

PC This macro certainly automates a time-consuming task. We have fine-tuned it to make it even more efficient; it's shown in Figure 3. There are a few things worth noting about it.

Since the statement in cell B6 comes before the (For) statement that begins the inner loop, COUNTER will contain an outer-loop value whenever 1-2-3 executes this statement. It then moves the cell pointer to the top of the appropriate column before beginning the series of passes through the inner loop. If the order of these statements is reversed, it won't work.

This streamlined macro "builds" an @UPPER, @LOWER, or @PROPER function around the current cell entry on the Edit line. For example, if the current cell contains the label "test" and you select

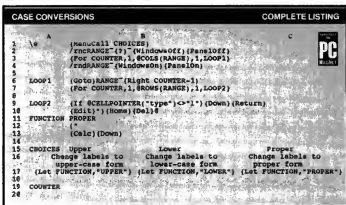


Figure 3: This macro converts all of the labels in the range you specify into the form you specify: either uppercase, lowercase, or proper.

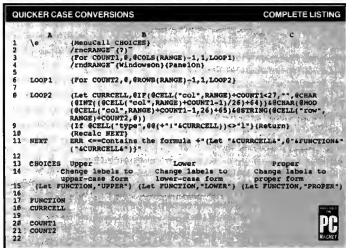


Figure 4: This macro executes faster than the one in Figure 3 because it replaces the labels in the range you specify without moving the cell pointer.

Proper from the custom menu, the Edit line will contain the function @PROPER("test") after 1-2-3 executes these statements. At this point, 1-2-3 recalculates the function, replacing it with its result (the label "Test"), and replaces the entry in the current cell (the label "test") with that result.

This macro demonstrates a useful technique: you can use the same cell as the counter for both loops. At first it may appear that this would cause problems. Suppose you selected a two-column by three-row range. When 1-2-3 began the first pass through the outer loop, it would enter the

value 1 into COUNTER. However, it would replace that value with the values 1, 2, and 3, respectively, during the three subsequent passes through the inner loop.

After making the third pass through the inner loop during the first pass through the outer loop, 1-2-3 would increase the value of COUNTER to 4. Since 4 is greater than the number of rows in the range (3), 1-2-3 would end the first pass through the outer loop and begin another. Since 4 is also greater than the number of columns in the range (the "stop" value of the outer loop), 1-2-3 shouldn't begin a second pass

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through that loop—but it does.

It remembers that COUNTER contained the value 1 at the beginning of the first pass through the outer loop. Consequently, before I-2-3 determined whether or not it should begin another pass through the outer loop, it changed the value of COUNTER to 2 (1 plus the value of COUNTER at the beginning of the previous pass through the outer loop), not 5 (1 plus the value of COUNTER at the end of the final pass through the inner loop). Since 2 is not greater than 2 (the number of columns in the range), I-2-3 made another pass through the outer loop.

The macro shown in Figure 4 executes

You can use the same cell as the counter for both the inner and outer loops in I-2-3.

even more quickly. Instead of moving the cell pointer to each cell in a range, one at a time (slowing execution—especially for large ranges—even though the screen is frozen), Figure 4 converts the labels in the range you specify without moving the cell pointer.

Similar to Figure 3, this one makes as many passes through outer and inner loops as there are columns and rows, respectively, in the range you specify. However, it uses a separate counter for each loop: COUNT1 (B20) for the outer loop and COUNT2 (B21) for the inner loop.

At the beginning of each pass through the outer loop, I-2-3 enters a new value into COUNT1. During the first pass through the outer loop, COUNT1 will contain the value 0; during the second pass, it will contain the value 1; and so forth. During the first pass through the inner loop during each pass through the outer loop, COUNT2 will contain the value 0; during each second pass through the inner loop, COUNT2 will contain the value 1; and so forth.

The first statement in the inner loop (cell B8) enters the label form of the ad-

dress of one of the cells in the range you specified into the cell named CURRCELL (B18). During the first pass through the inner loop during each pass through the outer loop, both COUNT1 and COUNT2 will contain the value 0; consequently, the statement in cell B8 will enter the address of the upper-left cell of the range into CURRCELL. During the second pass through the inner loop during the first pass through the outer loop, COUNT1 will contain the value 0 and COUNT2 will contain the value 1; therefore, the statement in cell B8 will enter the address of the second cell of the leftmost column of the range into CURRCELL.

During the first pass through the inner loop during the second pass through the outer loop, COUNT1 will contain the value 1 and COUNT2 will contain the value 0; consequently, the statement in cell B8 will enter the address of the topmost cell in the second column of the range into CURRCELL. During the second pass through the inner loop during the second pass through the outer loop, both COUNT1 and COUNT2 will contain the value 1; the statement in cell B8 will then enter the address of the second cell of the second column of the range into CURRCELL; and so forth.

The second statement in the inner loop (cell B9) tests to see if the cell whose address is stored in CURRCELL contains a label. If it doesn't, I-2-3 will begin the next pass through the inner loop. If it does, I-2-3 will execute the statement in cell B10, which commands it to recalculate the string formula

```
+*{Let "CURRCELL",0"&FUNCTIONS  
+"("CURRCELL")"}*
```

in cell B11. The result of this formula is a {Let} statement that instructs I-2-3 to replace the label in the cell specified by the entry in CURRCELL with an all-uppercase, all-lowercase, or proper version of that label—whichever you specified.

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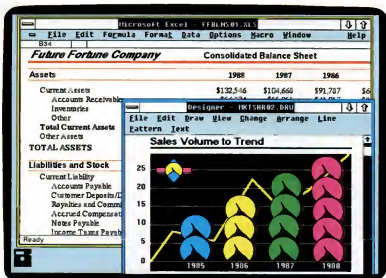
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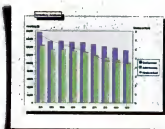
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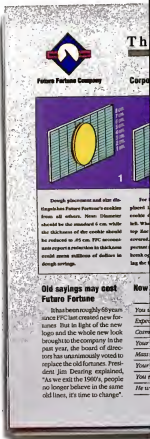
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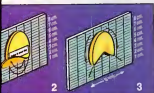


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by
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User-to-User

CREATE A TEXT DISPLAY PROGRAM

TEXTCOM.BAT (Figure 1) is a small no-hassle utility that creates compact text display programs. These display programs can be used as reminders or help screens. The output files are standalone executable .COM files and can be edited with standard text editors.

Use EDLIN to enter the three-line TEXTCOM.BAT. The crucial first line consists of 35 characters that must be entered carefully. The ASCII codes for the characters between ECHO and >TEMP.TXT are as follows:

```
190, 23, 1, 172, 130, 200, 246,  
200, 52, 229, 116, 7, 100, 2,  
205, 33, 235, 241, 144, 205, 32
```

To enter each character, hold down the Alt key, type the number on the numeric keypad, then release the Alt key. Note that the character generated by the last number, 32, is a space—don't accidentally delete it. Do not type the commas or spaces. Enter the second and third lines normally.

Now you can convert any text file to a .COM file by typing

```
TEXTCOM infile outfile
```

where *infile* includes the complete path and name of the text file and *outfile* includes the path and name of the executable file but without the .COM extension. The input file should be a standard text file terminated by

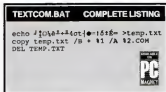


Figure 1: The bizarre characters in the first line of this batch file are actually a tiny program that makes any text file an executable file.

■ **CREATE A TEXT DISPLAY PROGRAM:**
Here is a unique batch file that will produce a .COM program using only ECHO and COPY.

■ **PATH MAGIC REVISITED:**
Get full control of your PATH, with a case-changing batch file as a bonus.

■ **EASE THE TRANSITION FROM MS-TO PC-DOS:**
You don't have to reformat your hard disk when you upgrade.

■ **CREATING AN INVALID FILENAME:** The DOS RENAME command can create files that aren't accessible by DOS itself.

a Ctrl-Z ('Z'). It may contain non-ASCII characters.

You can also convert keyboard entries into executable display files. At the DOS prompt, type

```
TEXTCOM CON outfile
```

Now enter your text, and then press 'Z and Enter.

You can modify the executable output files and TEXTCOM.BAT as long as you don't tamper with the first line. However, since not all word processors handle non-ASCII characters properly, experiment a bit with yours on TEXTCOM.BAT and output files.

Figure 2 is the disassembly of the stub program that TEXTCOM attaches to the front end of the text file. It is a bare-bones program; with a little careful programming, you can add features available in

BROWSE-type utilities. The trick is to avoid characters that cannot be edited, such as 'V', 'G', 'Z', and linefeed.

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Every file is just a collection of bytes. A text file contains only bytes that represent ASCII characters, plus a few control characters. The control characters have special meanings—character 8 ('H) is a backspace, 10 ('J) is a linefeed, 13 ('M) is a carriage return, and 26 ('Z) means end-of-file. These bytes are as likely as any other to appear in a program file, which is why you get odd results when you TYPE a .COM or .EXE file.

However, with careful programming it's possible to avoid any bytes that represent control characters. That's what TEXTCOM.BAT does. For example, it needs to test whether the current character is a 'Z end-of-file marker. But TEXTCOM can't make the comparison directly, because doing so would insert a 'Z into the file. So it inverts the character with NOT and compares the result with the inversion of 'Z.

Once you've created a .COM file with TEXTCOM.BAT, you may be able to edit it in your favorite program editor. The two requirements are that the editor not change

TEXTCOM.LST	COMPLETE LISTING
XXXX:0100 DE1701	MOV SI,0117
XXXX:0103 AC	LODSB
XXXX:0104 BADC	MOV AL,AL
XXXX:0105 7600	NOT AL
XXXX:0108 14E5	XOR AL,E5
XXXX:010A 7407	JZ 0113
XXXX:010C B402	MOV AH,02
XXXX:010E C021	INT 21
XXXX:0110 CB7F	JMP 0103
XXXX:0112 98	NOP
XXXX:0113 CD20	INT 20

Figure 2: Disassembling the first line of TEXTCOM.BAT with DEBUG produces this program stub.

User-to-User

the program bytes in the first line and that it end files with a "Z." If your editor meets these requirements, it should work.

PATH MAGIC REVISITED

PC Magazine has printed several items about changing the PATH environment variable, but I think that the best is Path Magic (User-to-User, February 29, 1988). The CHPATH.BAT utility gives you full control of your PATH with a few keystrokes.

When I upgraded to DOS 3.3, I modified this utility so that I could use it with the APPEND environment variable as well as the PATH. I also corrected the drawback of the old version noted at the end of the article (when you wanted to delete subdirectories, you had to type them in uppercase, exactly as they appeared in the PATH).

You'll need five batch files (one more than the old version) to use this utility. They are the main batch file CHG.BAT (Figure 3), the assistants CHG_SET1.BAT, CHG_SET2.BAT, and CHG_SET3.BAT (Figure 4), and UPGCASE.BAT (Figure 5), which sets an environment variable to the uppercase value of a string. Now if you want to remove the C:\DATA subdirectory from your PATH, it doesn't matter if you type CHG path c:\data -i at the DOS prompt.

Note that the switches used by the old version are left unchanged. They are

- -i to remove the directory;
- -b to add the directory at the beginning;
- -e to add the directory at the end;
- -db to delete the directory or directories from the beginning until the given directory;
- -de to delete the directories starting from the given directory until the end.

To use CHG.BAT, follow this syntax:

```
[dir][path]chg [path][append]
directory {-b | -e | -i | -db | -de}
```

For example, if your old path is

```
APPEND=C:\;.\DATA;D:\RESULTS;
```

issuing the command

```
CHG append .\data -i
```

will give you the new path

```
APPEND=C:\;D:\RESULTS;
```

CHG.BAT

COMPLETE LISTING

```
ECHO OFF
REM CHG.BAT a new version of PC MAGAZINE's
REM CHPATH Utility (in Vol.7 Mar.4)
IF %1==: GOTO ERROR
CALL UPGCASE %2 %1
IF %1%2==:PATH SET V5=PATH%1
IF %1%2==:APPEND SET V5=APPEND%1
IF %1%2==: GOTO ERROR
V5%1 > L.V5%1.BAT
CALL UPGCASE M %2
CALL UPGCASE P %1
IF %1%2==:DB CHG SET1 V5%1
IF %1%2==:DE CHG SET2 V5%1
IF %1%2==:I CHG SET3 V5%1
IF %1%2==:B V5%1%1%1;V5%1
IF %1%2==:E V5%1%1%1%1;
REM IF you don't end your path with a semicolon, change
REM the line above to "IF %1%2==:E V5%1%1%1%1;"
V5%1
SET M=
SET P=
SET V5=
GOTO END
:ERROR
ECHO Proper syntax is:
ECHO %2 (PATH | APPEND) DIRECTORY {-B | -E | -I | -DB | -DE }
:END
SET V5=
```

Figure 3: This batch file lets you manipulate the PATH or APPEND environment variables.

CHG.BAT creates L_PATH.BAT or L_APPEND.BAT for storing previous settings so that they can be reset without any problem at all. You should note, however, that this version of the utility can be used with DOS 3.3 or later only.

This is a very simple and powerful utility, useful for everyone who wants to modify these environment variables. I hope you'll find it interesting.

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PC To use this set of batch files with APPEND, you have to load APPEND in a specific way. The very first time you call APPEND, follow it with the /E command line parameter. This puts the APPEND path into the environment, where you are then able to view and manipulate it. Note that when you use the /E parameter, you won't be able to put any directories on the command line the first time you call APPEND.

When used for your PATH, CHG.BAT assumes you end your path with a semicolon. A final semicolon isn't necessary and may cause DOS to take a fraction longer when searching your path. If you don't end your path with a semicolon, change the 15th line as explained in the REM statements that follow it.

As usual, don't use APPEND unless you must. You get unpredictable results from commonplace program activi-

CHG.BAT's ASSISTANTS

```
ECHO OFF
REM CHG_SET1.BAT
CALL CHG SET2 %1;%2;%3;%4;%5;%6;%7;%8;%9;%10;%11;%12;%13;%14;%15;%16;%17;%18;%19;%20;%21;%22;%23;%24;%25;%26;%27;%28;%29;%30;%31;%32;%33;%34;%35;%36;%37;%38;%39;%40;%41;%42;%43;%44;%45;%46;%47;%48;%49;%50;%51;%52;%53;%54;%55;%56;%57;%58;%59;%60;%61;%62;%63;%64;%65;%66;%67;%68;%69;%70;%71;%72;%73;%74;%75;%76;%77;%78;%79;%80;%81;%82;%83;%84;%85;%86;%87;%88;%89;%90;%91;%92;%93;%94;%95;%96;%97;%98;%99;%100;%101;%102;%103;%104;%105;%106;%107;%108;%109;%110;%111;%112;%113;%114;%115;%116;%117;%118;%119;%120;%121;%122;%123;%124;%125;%126;%127;%128;%129;%130;%131;%132;%133;%134;%135;%136;%137;%138;%139;%140;%141;%142;%143;%144;%145;%146;%147;%148;%149;%150;%151;%152;%153;%154;%155;%156;%157;%158;%159;%160;%161;%162;%163;%164;%165;%166;%167;%168;%169;%170;%171;%172;%173;%174;%175;%176;%177;%178;%179;%180;%181;%182;%183;%184;%185;%186;%187;%188;%189;%190;%191;%192;%193;%194;%195;%196;%197;%198;%199;%200;%201;%202;%203;%204;%205;%206;%207;%208;%209;%210;%211;%212;%213;%214;%215;%216;%217;%218;%219;%220;%221;%222;%223;%224;%225;%226;%227;%228;%229;%230;%231;%232;%233;%234;%235;%236;%237;%238;%239;%240;%241;%242;%243;%244;%245;%246;%247;%248;%249;%250;%251;%252;%253;%254;%255;%256;%257;%258;%259;%260;%261;%262;%263;%264;%265;%266;%267;%268;%269;%270;%271;%272;%273;%274;%275;%276;%277;%278;%279;%280;%281;%282;%283;%284;%285;%286;%287;%288;%289;%290;%291;%292;%293;%294;%295;%296;%297;%298;%299;%300;%301;%302;%303;%304;%305;%306;%307;%308;%309;%310;%311;%312;%313;%314;%315;%316;%317;%318;%319;%320;%321;%322;%323;%324;%325;%326;%327;%328;%329;%330;%331;%332;%333;%334;%335;%336;%337;%338;%339;%340;%341;%342;%343;%344;%345;%346;%347;%348;%349;%350;%351;%352;%353;%354;%355;%356;%357;%358;%359;%360;%361;%362;%363;%364;%365;%366;%367;%368;%369;%370;%371;%372;%373;%374;%375;%376;%377;%378;%379;%380;%381;%382;%383;%384;%385;%386;%387;%388;%389;%390;%391;%392;%393;%394;%395;%396;%397;%398;%399;%400;%401;%402;%403;%404;%405;%406;%407;%408;%409;%410;%411;%412;%413;%414;%415;%416;%417;%418;%419;%420;%421;%422;%423;%424;%425;%426;%427;%428;%429;%430;%431;%432;%433;%434;%435;%436;%437;%438;%439;%440;%441;%442;%443;%444;%445;%446;%447;%448;%449;%450;%451;%452;%453;%454;%455;%456;%457;%458;%459;%460;%461;%462;%463;%464;%465;%466;%467;%468;%469;%470;%471;%472;%473;%474;%475;%476;%477;%478;%479;%480;%481;%482;%483;%484;%485;%486;%487;%488;%489;%490;%491;%492;%493;%494;%495;%496;%497;%498;%499;%500;%501;%502;%503;%504;%505;%506;%507;%508;%509;%510;%511;%512;%513;%514;%515;%516;%517;%518;%519;%520;%521;%522;%523;%524;%525;%526;%527;%528;%529;%530;%531;%532;%533;%534;%535;%536;%537;%538;%539;%540;%541;%542;%543;%544;%545;%546;%547;%548;%549;%550;%551;%552;%553;%554;%555;%556;%557;%558;%559;%560;%561;%562;%563;%564;%565;%566;%567;%568;%569;%570;%571;%572;%573;%574;%575;%576;%577;%578;%579;%580;%581;%582;%583;%584;%585;%586;%587;%588;%589;%590;%591;%592;%593;%594;%595;%596;%597;%598;%599;%600;%601;%602;%603;%604;%605;%606;%607;%608;%609;%610;%611;%612;%613;%614;%615;%616;%617;%618;%619;%620;%621;%622;%623;%624;%625;%626;%627;%628;%629;%630;%631;%632;%633;%634;%635;%636;%637;%638;%639;%640;%641;%642;%643;%644;%645;%646;%647;%648;%649;%650;%651;%652;%653;%654;%655;%656;%657;%658;%659;%660;%661;%662;%663;%664;%665;%666;%667;%668;%669;%670;%671;%672;%673;%674;%675;%676;%677;%678;%679;%680;%681;%682;%683;%684;%685;%686;%687;%688;%689;%690;%691;%692;%693;%694;%695;%696;%697;%698;%699;%700;%701;%702;%703;%704;%705;%706;%707;%708;%709;%710;%711;%712;%713;%714;%715;%716;%717;%718;%719;%720;%721;%722;%723;%724;%725;%726;%727;%728;%729;%730;%731;%732;%733;%734;%735;%736;%737;%738;%739;%740;%741;%742;%743;%744;%745;%746;%747;%748;%749;%750;%751;%752;%753;%754;%755;%756;%757;%758;%759;%760;%761;%762;%763;%764;%765;%766;%767;%768;%769;%770;%771;%772;%773;%774;%775;%776;%777;%778;%779;%780;%781;%782;%783;%784;%785;%786;%787;%788;%789;%790;%791;%792;%793;%794;%795;%796;%797;%798;%799;%800;%801;%802;%803;%804;%805;%806;%807;%808;%809;%810;%811;%812;%813;%814;%815;%816;%817;%818;%819;%820;%821;%822;%823;%824;%825;%826;%827;%828;%829;%830;%831;%832;%833;%834;%835;%836;%837;%838;%839;%840;%841;%842;%843;%844;%845;%846;%847;%848;%849;%850;%851;%852;%853;%854;%855;%856;%857;%858;%859;%860;%861;%862;%863;%864;%865;%866;%867;%868;%869;%870;%871;%872;%873;%874;%875;%876;%877;%878;%879;%880;%881;%882;%883;%884;%885;%886;%887;%888;%889;%890;%891;%892;%893;%894;%895;%896;%897;%898;%899;%900;%901;%902;%903;%904;%905;%906;%907;%908;%909;%910;%911;%912;%913;%914;%915;%916;%917;%918;%919;%920;%921;%922;%923;%924;%925;%926;%927;%928;%929;%930;%931;%932;%933;%934;%935;%936;%937;%938;%939;%940;%941;%942;%943;%944;%945;%946;%947;%948;%949;%950;%951;%952;%953;%954;%955;%956;%957;%958;%959;%960;%961;%962;%963;%964;%965;%966;%967;%968;%969;%970;%971;%972;%973;%974;%975;%976;%977;%978;%979;%980;%981;%982;%983;%984;%985;%986;%987;%988;%989;%990;%991;%992;%993;%994;%995;%996;%997;%998;%999;%1000;%1001;%1002;%1003;%1004;%1005;%1006;%1007;%1008;%1009;%1010;%1011;%1012;%1013;%1014;%1015;%1016;%1017;%1018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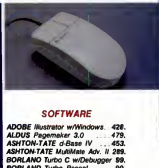
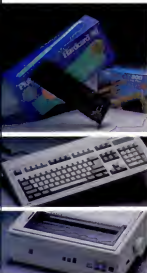
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User-to-User

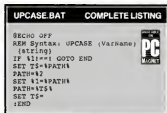


Figure 5: This batch file sets an environment variable to the uppercase of a string.

ties when APPEND is active. For example, suppose your program reads and closes a file, processes any changes you've made, and writes the file back to disk. And suppose the file isn't in the current directory but is on the APPEND path. When your program opens the file, it seems to find it in the current directory. Thus it will write the file in the current directory rather than in the directory it came from.

The UPCASE batch file in Figure 5 may be handy in other circumstances. It uses the fact that DOS converts the PATH string into all capital letters. Of course, you have to have enough free environment space to hold a copy of the PATH while UPCASE is using it.

EASE THE TRANSITION FROM MS-TO PC-DOS

As we move into the age of connectivity, transitions often cause unforeseen problems. We had over 300 AT clones running a variety of MS-DOS versions, 2.0 through 3.3. Unfortunately, PC-to-mainframe software connectivity is an IBM world—you can use only IBM PC-DOS 3.3 or later.

When we tried to upgrade using the DOS SYS C: command, we ran into the familiar message: "No room on destination disk." The thought of having to back up, reformat, and restore data on more than 300 hard disks was not pleasant by any means. After many calls to DOS experts and manufacturers' hotlines, I began experimenting on my own and came up with the following procedure.

The first step is to use your current brand of DOS to upgrade to 3.3. To do this, issue the SYS C: command from the most current MS-DOS 3.3 master disk.

Next, rename the two hidden system files (IO.SYS and MSDOS.SYS) to their IBM equivalents (IBMBIO.COM and IBMDOS.COM). Then copy COMMAND.COM

from the IBM PC-DOS 3.3 disk over your system's old COMMAND.COM file. Now you are ready to boot the system from the IBM PC-DOS 3.3 disk and issue the SYS C: command. At this point, the system files transfer easily.

Finally, delete the old MS-DOS programs and replace them with IBM PC-DOS 3.3 files.

Once learned, it's a pretty simple process. It takes only a few minutes on each system, compared with hours using the other method.

J. Allan Zehner
Milwaukee, Wisconsin



It's not quite as easy as this. The step that may cause trouble is renaming the hidden system files. To do anything to these files, you have to make them nonhidden and nonsystem. PC Magazine's ATTR.COM will do the job, as will many public-domain utilities. The

Unfortunately,
PC-to-mainframe
software connectivity
is an IBM world.

sequence of commands might be

```
ATTR -S-H IO.SYS
REN IO.SYS IBMBIO.COM
ATTR -S-H MSDOS.SYS
REN MSDOS.SYS IBMDOS.COM
ATTR +S-H IBMBIO.COM
```

Now you're ready to use the SYS command to transfer PC-DOS onto your system. Note that you may be able to skip the step of updating your MS-DOS to 3.3 before switching to PC-DOS.

The earliest versions of DOS absolutely insisted that the two hidden system files reside in a particular location on the disk. To go from DOS 1.0 to DOS 2.0 required a backup-reformat-restore sequence. Later versions required the hidden system files only to begin in a fixed location. Starting with DOS 2.0, SYS was enough to install a new DOS version. However, many people reformatted when upgrading to DOS 3.x, to take advantage of the smaller cluster size available on hard disks.

CREATING AN INVALID FILENAME

There is a bug or at least an inconsistency in DOS 3.2 and 3.3 (I haven't checked earlier versions). If you issue the command

```
RENAME *.* *.???
```

where Q is any valid character not equal to a space, all files without extensions get a new name of the type filename.Q. That is, the first character of the extension will be a space. This is a valid DOS filename, because the space is a valid character.

On the other hand, the space character is used as a separator in DOS commands so you can do nothing with these files. For example, you cannot rename, delete, or type them. At this point one could ask what is wrong with DOS. At the very least it's inconsistent that you can use a valid DOS command to create filenames that can't be recognized by other DOS commands.

Fortunately, you can rename each of the *.Q files by issuing the command

```
RENAME *.*.???.*.*.*
```

Otherwise you could end up with a disk littered with inaccessible files.

Marek Kupiszewski
Warsaw, Poland

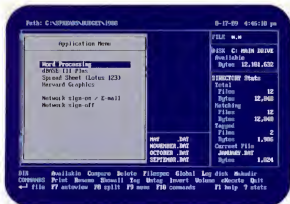


Some programs use filenames or even directory names with embedded spaces to provide a small measure of security against user error. If a directory is named MY STUFF, the average user won't be able to get into it. And if the directory name is a series of spaces and ASCII character 255 (which prints as a space) it'll be still more difficult.

Even in DOS 2.0, you can create a filename with embedded spaces. Likely as not, you'll do it by accident, and then have a tough time figuring out how to do something with the file. Such filenames may be handy for compiled programs, but it's too bad it's so easy to create them using DOS itself.

SHARE YOUR SECRETS

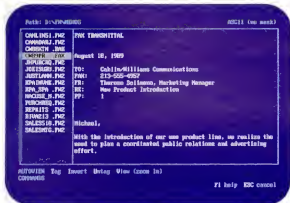
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Power User

A CREATIVE USE OF AN ERROR MESSAGE

An idea that has proven valuable for me is to make all form letters and boilerplate correspondence files read-only after having tweaked them to just the way I want them. Doing this saves me from the heartache of ruining a blank form by accidentally saving a filled-in letter in its place. (It's easy to do—just be in a hurry and type a Y at the wrong time.) One way to make a file read-only is to use the Go to DOS command, as shown in Figure 1.

After using this command, attempting to store a document with the same name as a read-only file will generate a "File creation error" code and a prompt for a new filename. If you decide to change the form letter, you will need to change the file status to read/write before attempting to save the modified version of the form. To do this, go through the same sequence as in Figure 1, but type -R instead of +R. Then save the updated version and reset the read-only attribute.

A "File creation error" code is also generated when you reach the DOS limit of 112 files on a floppy. And you can hit this limit well before you use all the disk space. If you use *WordPerfect*, for instance, and it's set to save the latest version of an updated file with a .BK1 extension, the proliferation of backup files can bring you to the 112-file limit in no time at all.

If you save an updated version of a file to a floppy and you receive the "File creation error" message, enter

<F1>	Cancel the Save command
<Ctrl-F1>	Go to DOS
DEL A*.BK1	Delete all files on Drive A with a .BK1 extension
EXIT<CR>	Return to WordPerfect

while the error message is still displayed. This deletes all backup files on the disk. Or,

■ **A CREATIVE USE OF AN ERROR MESSAGE:** Here are two ways you can put the "File creation error" to work for you.

■ **FINDING THE RIGHT WINDOW IN WORD:** Automatically locate the right window in Word 4.0 when more than one is open.

■ **AVOID ANNOYING COPYRIGHTS.** Here's how you can suppress the copyright screens in dBASE III Plus and IV.

■ **ALPHABETIZING MAILING LISTS:** A handy tip on how to index on street addresses in dBASE.

since you actually need to erase only one file to make room for the file currently on the screen, revise this to delete a specific file. Now try to save the updated version of your file.

Note: Even though your file save was not successful earlier, the previous version of that file was renamed to (filespec).BK1. If you used the script above and deleted all

backups, the only version of the document that exists is the one on the screen (in the computer's RAM). So, the very next thing you must do is save the updated document again.

The two scripts above won't work as macros since they involve jumping out of *WordPerfect*. The keystrokes that would need to be played at the DOS prompt will not be executed.

David Graham
Norfolk, Virginia



The limit is not really 112 files per floppy disk, but 112 files in the root directory of a floppy disk. You can put many more files on one floppy by simply creating a subdirectory to hold them. So you can avoid that dangerous moment when the only current copy of your file is the one in RAM. Create a subdirectory on your disk and save the file in it. You don't even have to leave *WordPerfect* to do it—hit F5 followed by an equals sign to change the default directory and enter a name of your choice. *WordPerfect* will prompt for confirmation and then create that directory for you. Save your file in the newly created subdirectory and then go and clean up the *.BK1 files. Of course, if the disk actually is full, you'll have to delete some files or save your document on another disk.

Besides issuing the "File creation error" message when you try to save, *WordPerfect* 5.0 gives you another indication that you're working with a read-only file. It puts square brackets around the filename

HOW TO MAKE A FILE READ-ONLY

```
<Ctrl-F1>
ATTRIB +R (filespec) <cr>

EXIT<cr>
```

Go to DOS
This assumes that the DOS external command ATTRIB.EXE is in the root directory or the path.
Return to WordPerfect

COMPLETE LISTING



Figure 1: The Go to DOS command lets you make a file read-only. Then if you store a document with the same name, DOS will generate a "File creation error" message.

Power User

on the status line. For example

```
{C:\FORMS\FORMLETR.3}
```

—Neil J. Rubenking


FINDING THE RIGHT WINDOW IN WORD

When writing multiscreen macros in Microsoft Word, it is often helpful to ensure that the proper window is active. For example, the following macro will guarantee that you can get to window 2 of a two-window split:

```
<Esc>w<If Field=2><Esc>Xis<
<Esc><F1><Endif>
```

If you have more than two windows open, you can repeat the set of commands—twice for three windows, three times for four windows, and so on. By simply replacing the Field entry with the window that you want to go to and by placing the appropriate sequence in your macro, you can safely move about without having to worry about which window you were in when you started.

John Cusolito
West Los Angeles, California

 Useful as this technique is, there is a more elegant way to obtain the same effect. The following macro will similarly ensure that window 2 is the active window:

```
<Esc>w<While Field<2>
<esc><F1>w<Endwhile><esc>
```

The advantage of the While . . . Endwhile statement is that this macro doesn't care how many windows are open. It will take you to window 2 in any case—as long as there is a window 2.

Note that in Word 5.0 you don't need this since the new variable *window* will let you set the active window with the command

```
<set window = n>
```

where *n* is the window number that you want to use.—M. David Stone

AVOID ANNOYING COPYRIGHTS

While delighted with *dBASE IV*'s many new features, I find it increasingly irritating to

look at the Ashton-Tate logo and copyright screens every time I start up the program.

Fortunately, the solution is simple. Just load *dBASE* with this DOS command:

```
dbase /t
```

This /t switch also works with runtime modules, using the command

```
runtime /t <program>
```

If you can't remember the switch, or want to make loading this way automatic, try putting the startup command in a batch file.

John H. Redman
Lakeside, California



Ashton-Tate showed good taste when it included the simple /t switch to bypass these screens. A short copyright screen still appears, but it's far less intrusive.

The single copyright screen in *dBASE III Plus* can be minimized by hitting Enter twice when loading the program. DOS

**A /t switch included in
dBASE lets you
view a less intrusive
Ashton-Tate logo.**

stores the second Enter in the keyboard buffer. The instant the copyright is finished being written, *dBASE* receives the second Enter and clears the famous (or infamous) opening statement, "Press Enter to assent to the License Agreement and begin *dBASE III Plus*."

You can accomplish the same thing using the KEY-FAKE utility, which appeared in the December 24, 1985, issue, in a batch file. For example,

```
REN DO.BAT
KEY-FAKE 13
dBASE
```

KEY-FAKE injects the extra Enter into the keyboard buffer and calls *dBASE*. When *dBASE* takes control, the opening statement is automatically cleared. And if your CONFIG.DB file specifies a program to be run (by including the line: COM-

MAND=DO PROGNAME), your program will begin without further commercial interruption.—Brad Stark

ALPHABETIZING MAILING LISTS

When a *dBASE* user sorts or indexes on an address field, the street names normally do not line up in alphabetical order because the first several characters in the field are usually the numeric street number.

To alphabetize by street name and number, use the following index command:

```
INDEX ON SUBSTR(address,AT(" ",  
address)+1,6)+STR(VAL(address),4)
```

The AT() function finds the first space character, so the index is built on the first six characters that follow. The STR(VAL()) functions form the second part of the index and put different numbers on the same street in sequence.

Doug Willis
Webster, New York



This is a simple, useful technique that is helpful in arranging most records by street name for mailing lists or preparing delivery routes, and purging certain types of lists.

Unfortunately, some records will still index incorrectly. For example, streets preceded by compass directions like 1 East Main Street will be indexed on East rather than Main; One Park Avenue will not be next to 1 Park Avenue; PO Box 12 will be indexed on Box; and Statler Office Park will be sequenced with the O's.

Interestingly, the U.S. Postal Service will standardize a large file for you free of charge. Their Zip+4 disk coding service uniformizes the street address line's format and supplies the correct 9-digit zip code. It takes several weeks, but I'm told they do good work, and you can't beat the price! For further information, contact your local postal representative.—Brad Stark

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Languages

USING ONE FUNCTION TO DERIVE OTHERS

The inverse trigonometric functions are often useful. For example, the inverse sine (or arc sine) function returns the angle whose sine is its argument, as is shown in the following:

```
sin(angle) = value  
arcsin(value) = angle
```

The inverse tangent is the only inverse trigonometric function provided in Turbo Pascal, but the other inverse functions can be calculated in terms of it. Figure 1 shows the unit TRIG, written in Turbo Pascal 4.0, which contains inverse sine and inverse cosine functions.

Each of the functions takes a real value x as an argument. Its outputs are the function value and a Boolean variable indicating an invalid argument. The functions check for boundary values and values that would cause division-by-zero errors in the ArcTan arguments. Let's look at the derivation of the inverse sine function.

The aim is to calculate the inverse sine in terms of the inverse tangent. First, remembering that the definitions are based on the unit circle and on right triangles, we define

$$\sin(\theta) = y / r$$

where y is the length of the side (in the right triangle) opposite the angle θ , and r is the length of the hypotenuse. Since $\text{radius} = 1$ on a unit circle,

$$\theta = \arcsin(y)$$

Similarly,

$$\theta = \arctan(y/x)$$

where x is the length of the side adjacent to the angle θ .

In a right triangle,

$$\text{sq}(y) + \text{sq}(x) = \text{sq}(r) = 1$$

■ USING ONE FUNCTION TO DERIVE OTHERS: Turbo Pascal has the ArcTan function; here's how to derive ArcSin and ArcCos from it.

■ INPUT AND EDIT FIELDS IN QUICKBASIC: Input and edit data-entry fields in QuickBASIC with ease using this capable input routine.

and, therefore,

$$x = \sqrt{1 - \text{sq}(y)}$$

Substituting for x , we have

$$\arcsin(y) = \theta = \arctan(y / \sqrt{1 - \text{sq}(y)})$$

The derivation of the inverse cosine function is similar.

Figure 2 gives a sample usage of the inverse sine function. The program prompts the user to input the lengths of the side a (opposite the angle in question) and the hypotenuse for a right triangle. It will then calculate the angle opposite a and display it.

Alan Thomas
Fredericksburg, Virginia



It's not uncommon for programming languages to supply only the inverse tangent, leaving the user to then create the other inverse functions or to purchase a math library that includes them.

Unfortunately, the user-written routines often take much longer to run than the built-in ArcTan function. If your programs require the use of a lot of inverse trigonometric functions, you should really be sure to study them carefully and look for ways to use ArcTan directly, rather than ArcSin or ArcCos.

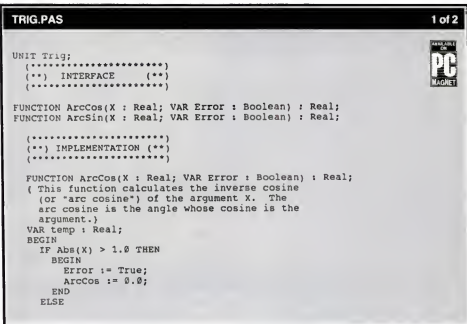


Figure 1: Inverse sine and cosine functions for Turbo Pascal, calculated in terms of the inverse tangent function.

```

BEGIN
  Error := False;
  IF X = 0.0 THEN ArcCos := Pi/2.0
  ELSE
    IF X = -1.0 THEN ArcCos := Pi
    ELSE
      BEGIN
        temp := ArcTan(Sqrt(1.0-Sqr(X)))/X;
        IF temp < 0 THEN ArcCos := temp+Pi
        ELSE ArcCos := temp;
      END;
    END;
  END;
  {function ArcCos}

FUNCTION ArcSin(X : Real; VAR Error : Boolean) : Real;
{ This function calculates the inverse sine
(or "arc sine") of the argument X. The
arc sine is the angle whose sine is the
argument. }
BEGIN
  IF Abs(X) > 1.0 THEN
    BEGIN
      Error := True;
      ArcSin := 0.0;
    END
  ELSE
    BEGIN
      Error := False;
      IF X = -1.0 THEN ArcSin := -Pi/2.0
      ELSE
        IF Abs(X) = 1.0 THEN ArcSin := Pi/2.0
        ELSE ArcSin := ArcTan(X/Sqrt(1.0-Sqr(X)));
      END;
    END;
  END;
  {function ArcSin}

END.
{unit Trig}

```

Note the following expression in TRIGDEMO:

```

angle := 360.0/ArcSin
(a/c, ArcSinError)/(2.0*Pi);

```

Version 5 "folds" constants—it performs any constant calculations at compile time. The expression below is equivalent but requires less calculation:

```

angle := 360.0/(2.0*Pi)*ArcSin
(a/c, ArcSinError);

```

The compiler calculates $360.0/(2.0\pi)$ and inserts that value in the code. Now the program performs only one multiplication at runtime, rather than a multiplication and a division.—Neil J. Rubenking

INPUT AND EDIT FIELDS IN QUICKBASIC

I write database applications in QuickBASIC, and one of the biggest problems I face is restricting user input to a given number of characters. BASIC's INPUT command is all but useless, because anyone can enter nearly anything and your program has no way to control it. Worse, there's no way to edit an existing string.

To solve this frequent problem I wrote the EDITOR subprogram shown in Figure 3. EDITOR expects four parameters to be passed to it—the string being input or edited, the starting and ending rows, and an integer that returns the last key pressed. Simply move the cursor to the correct row before calling EDITOR, and it will handle all normal character entry, as well as inserting and deleting. The KeyCode variable tells your program how editing was terminated by returning a code that corresponds to the last key pressed.

For example, if the user pressed Enter, then KeyCode will return holding 13. Extended keys such as the Up/Arrow and Shift-Tab are returned as a negative version of their extended key code. This lets you easily distinguish those keys from normal ASCII character keys.

Don Malin
Norwalk, Connecticut



Based on the number of input routines PC Magazine receives, entering and editing data is obviously an important area for many programmers. However, this is the first BASIC input routine that was acceptable for publication in this column.

Besides doing the most with the fewest

```


PROGRAM TrigDemo;
{ This is an example to demonstrate use of the inverse
trigonometric function ArcSin (inverse sine).
The program calculates the angle of a right triangle with a
hypotenuse "c" and a side "a" opposite the angle.
The user is prompted for the lengths of the opposite
side and of the hypotenuse. If the input is valid,
the program then displays the value of the angle in
degrees. }
USES Trig, Crt;

VAR
  a : Real;      {length of the side opposite the angle in question}
  c : Real;      {length of the hypotenuse}
  ArcSinError : Boolean; {error return from ArcSin function}
  angle : Real;  {the calculated angle}
  Answer : Char; {answer to done prompt}

BEGIN
  ClrScr;
  REPEAT
    Write('Input the length of the side opposite ');
    Write('the angle in question> ');
    ReadLn(a);
    Write('Input the length of the hypotenuse> ');
    ReadLn(c);
    {calculate the angle and convert it to degrees.}
    angle := 360.0/ArcSin(a/c, ArcSinError)/(2.0*Pi);
    IF ArcSinError THEN
      WriteLn('***** ERROR in inverse sine calculation *****')
    ELSE WriteLn('The angle is ', angle:1:1);
    WriteLn;
    Write('Are you done? ');
    Answer := UCase(ReadKey); WriteLn(Answer);
    UNTIL Answer = 'Y';
  END.

```

Figure 2: TRIGDEMO demonstrates a use for the ArcSin function shown in Figure 1 above.



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Recently, Dr. Pournelle looked at Northgate's 80386 Pipeline Page Mode system and reported in BYTE July, 1989 (excerpted):

*Jerry Pournelle holds a doctorate in psychology and is a writer who also earns a comfortable living writing about computers, science and futurology.



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EDITOR.BAS

1 of 2

```

***** EDITOR.BAS
DEFINT a-z
DECLARE SUB Editor (Text$, LeftCol, RightCol, KeyCode)

COLOR 7, 1
CLS

COLOR 1, 1
Text$ = "This is a test"
LeftCol = 78
RightCol = 48
LOCATE 15

DO
    Editor Text$, LeftCol, RightCol, KeyCode

    'Do until Enter or Escape is pressed
    LOOP UNTIL KeyCode = 13 OR KeyCode = 27

COLOR 7, 1

SUB Editor (Text$, LeftCol, RightCol, KeyCode)
    '----- Find the cursor's size in scan lines
    SET LOC = 1
    IF PEEK(LOC) = 0 THEN
        'Peak at low memory to see
        'what type of monitor we have
        'Monochrome case 13 scan lines
        ' (numbered 8 to 12)
        'Color case 8 (8 to 7)
    ELSE
        'Set inverse video for editing
        'Make some sample text
        'Set left column for editing
        'Ditto for right column
        'Set the line number for editing
    END IF

    'Edit the field
    Editor Text$, LeftCol, RightCol, KeyCode

    'Back up the text pointer
    LOCATE 1, 1
    'Print the editing string
    PRINT LOC;

    '----- Main loop for handling key presses
    DO
        LOCATE 1, LeftCol + TextPos - 1, 1
        'Locate the cursor, turn it on
        DO
            Key = INKEY$
            'Wait for a key press
            LOOP UNTIL LEN(Key)
            IF LEN(Key) = 1 THEN
                KeyCode = ASC(Key)
                'Make a key code from Key$
                'Single character key
            ELSE
                KeyCode = -ASC(RIGHT$(Key, 1))
                'Extended keys are negative
            END IF

            '----- Branch according to the key pressed
            SELECT CASE KeyCode
                CASE 8
                    TextPos = TextPos - 1
                    'Back up the text pointer
                    LOCATE 1, LeftCol + TextPos - 1, 1
                    'Locate 1 to the left
                    IF TextPos > 8 THEN
                        IF ISERR THEN
                            MID$(Edit$, TextPos) = MID$(Edit$, TextPos + 1)
                            'Translates the string
                            '1 character to the left
                            MID$(Edit$, TextPos) = " "
                        END IF
                        PRINT MID$(Edit$, TextPos);
                        'Print the new part of text
                    END IF
                CASE 13, 27
                    'Enter or Escape
                    EXIT DO
                    'Bail out
            END SELECT
        LOOP
    
```

Figure 3: This powerful QuickBASIC input routine allows both entering and editing a string.

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Languages

EDITOR.BAS

2 of 2

```
'----- Letter keys
CASE 32 TO 254
  LOCATE , , 8 'Turn the cursor off
  IF INSERT THEN 'Expand the text string
    MID$(Edit$, TxtPos) = K$ + MID$(Edit$, TxtPos)
    PRINT MID$(Edit$, TxtPos); 'Print the expanded part
  ELSE
    MID$(Edit$, TxtPos) = K$ 'Put the new letter in string
    PRINT E$; 'Print the letter
  END IF
  TxtPos = TxtPos + 1 'Increment the text pointer

'----- Left arrow
CASE -75
  TxtPos = TxtPos - 1 'Decrement the text pointer

'----- Right arrow
CASE -77
  TxtPos = TxtPos + 1 'Increment the text pointer

'----- Home
CASE -71
  TxtPos = 1 'Move text pointer to 1

'----- End
CASE -79
  'Look backwards
  FOR N = LEN(Edit$) TO 1 STEP -1
    IF MID$(Edit$, N, 1) <> " " THEN EXIT FOR
  NEXT
  TxtPos = N + 1 'Set pointer to last char +1
  IF TxtPos > LEN(Edit$) THEN TxtPos = LEN(Edit$)

'----- Insert key
CASE -82
  Insert = NOT Insert 'Toggle the Insert state
  IF INSERT THEN 'Adjust the cursor size
    LOCATE , , CsrSize \ 2, CsrSize
  ELSE
    LOCATE , , CsrSize - 1, CsrSize
  END IF

'----- Delete
CASE -83
  MID$(Edit$, TxtPos) = MID$(Edit$, TxtPos + 1) 'Truncate the text
  LOCATE , , 8 'Print the truncated part
  PRINT MID$(Edit$, TxtPos);

CASE ELSE
  EXIT DO 'All other keys, bail out
END SELECT

'If cursor is out of field, quit editing
LOOP UNTIL TxtPos < 1 OR TxtPos > LEN(Edit$)

Text$ = RTRIM$(Edit$) 'Trim the right side of text

END SUB
```

lines of code, EDITOR provides an excellent example of modern structured coding using QuickBASIC. Particularly appealing is the way the routine can be reentered by simply calling it again. By placing the edit call within a DO loop, as in the accompanying demo, Mr. Malin has allowed illegal keys to be either trapped or ignored at the programmer's option. Further, this action is completely transparent to the user, because the cursor is retained within the editing field.—Ethan Winer

SPEAK YOUR LANGUAGE

Share your knowledge of BASIC, C, Pascal, FORTRAN, and COBOL with Languages readers. We'll pay you \$50 or more for any tips we print, *plus an extra \$25 if you submit your letter on-disk*. If you do, please include a printed copy. Mail contributions to Languages, PC Magazine, One Park Avenue, New York, NY 10016, or upload them to PC MagNet (see the "By Modem" sidebar in the Utilities column).

edited by
Tony Rizzo

Tutor

AUDIO CD PLAYERS AND CD-ROM

I would like to know what the difference is between an audio CD player and a CD-ROM player. Why are CD-ROM players so much more expensive? Is there any way to modify an audio CD player to play CD-ROMs? If so, how? Any light that you can shed would be appreciated.

Ken Lauria
South Ozone Park, New York



Audio and CD-ROM players have much in common. They both use the same laser technology to read their respective disks, and various companies even use the same basic chassis, which includes the power supply, for both their audio and CD-ROM players.

The differences begin to show up when it comes time to interpret the information encoded on the disks themselves. Audio CDs contain musical information that goes through a digital-to-analog conversion process through DACs (Digital-Analog Converters). The digital information is converted into analog sound we hear as music. An audio CD contains information that makes sense musically.

A CD-ROM disk will actually play in an audio CD player. Unfortunately, the sound that emerges if one were to try this would no doubt be highly offensive, and would probably be damaging to your speakers. This is because CD-ROMs do not contain musical information.

What CD-ROM disks do contain is information stored in what is known as *High Sierra* format, a standard means of encoding binary data onto a CD-ROM disk. The name *High Sierra* evolved from the High Sierra Group, a collection of manufacturers (among them Sony and Philips, the inventors of CD technology) with a large interest in CD-ROM who banded together to forge the standard.

A CD-ROM player needs to have some means of interfacing with your computer. This requires an interface board for your computer and an interface within the CD-ROM player; CD-ROM drive manufactur-

■ **AUDIO CD PLAYERS AND CD-ROM:** Learn how regular CD players and CD-ROM are different.

■ **CPU SPEED AND RAM ACCESS TIME:** Understand the relationship between CPU speed and RAM access time.

ers have standardized on the SCSI interface. When you purchase a CD-ROM player you therefore end up with a machine with a built-in SCSI port and an interface card for your computer.

There is also one additional—and quite crucial—piece to this puzzle: the software driver needed to let your computer communicate with the CD-ROM drive. In order to make this software work, Microsoft developed a set of CD-ROM extensions for DOS. The extensions consist of a TSR program called MSCDEX.EXE, which the user installs, and a device driver developed by the manufacturer, which is loaded through the CONFIG.SYS file.

MSCDEX.EXE provides the interface to DOS itself; it takes the unique character of the CD-ROM drive and makes it appear to DOS as just another (very large) hard drive. Actually, MSCDEX.EXE tricks DOS into thinking it is reading a very-large-capacity network drive, but that tale is beyond the scope of this column. MSCDEX.EXE can read any CD-ROM disk that uses the *High Sierra* format.

Why does a CD-ROM player, the only exterior control for which there is usually an open/close button, cost so much more than a regular audio CD player? Especially when you consider all the features a \$250 audio player gives you? Some of this can be attributed to the need to build interface hardware into the machine, to build the card that goes into the computer, and to develop the device driver for it. Part of it can

be attributed to the relatively low volume of machines produced. The cost of CD-ROM players will undoubtedly come down soon enough. For now, low demand will keep prices high in relation to their audio counterparts.

To make the expense of a CD-ROM player more palatable, manufacturers are beginning to introduce players with limited audio capability through the use of inexpensive DACs, with left and right audio output jacks. I'm aware of at least one CD-ROM player with relatively good audio output selling for under \$700. An alternative means of gaining audio sound is through a headphone jack utilizing some sort of emulation software—strictly for “noncritical” listening to your music.

Can you convert your audio CD player into a CD-ROM player? No. Aside from the difficulty of getting the player to interface to your computer—no small electronic task—Microsoft distributes the CD-ROM extensions only to drive manufacturers. Developing the software interface becomes, for the most part, impossible.

Fortunately, there are some indications that the price of CD-ROM players will drop soon. The best thing to do if you are on a tight budget and really want one is just to hold on a while longer.—Tony Rizzo

CPU SPEED AND RAM ACCESS TIME

I'm a bit confused by the many speed issues relating to personal computers. I understand what a wait state is, and I understand what the speed of the CPU itself is. But I'm not sure what the relationship between CPU speed, wait states, and RAM access time is. Can you shed some light on the topic?

Marc Alphonse
Trinidad, West Indies



Optimum performance in a PC is closely related to the interaction between the CPU and RAM. To gain the best performance, the speed at which the memory subsystem can deliver

Tutor

data must be properly balanced against the speed at which the system's CPU can handle it. Ideally, the length of time it takes RAM to deliver data should be less than the amount of time it takes the CPU to get ready for it, allowing a CPU to operate with zero wait states. If the RAM circuitry cannot deliver data fast enough, wait states must be inserted to keep the CPU from trying to act on data it hasn't received yet. Faster CPUs will require proportionally faster (and more expensive) RAM—slower (but cheaper) RAM will require that wait states be inserted, causing notable performance degradation of fast CPUs.

How quickly a microprocessor can accept data after making a request through its Bus Interface Unit is determined by clock speed and the number of clock cycles required to make a memory access. After a read request is made, the 8088 and 8086 processors require four clock cycles to get ready for incoming data. The 80286 and 80386 require only two clock cycles. At 4.77 MHz, an 8088 needs 840 nanoseconds to complete a memory access—four clock cycles at 210 ns. each. At the other end of the spectrum, a 33-MHz 386 machine, with its superior clock speed and design, can accept data as fast as 60 ns. after requesting it.

Balanced against the CPU's clock speed and memory access time is how fast the RAM circuitry can deliver data. The rated access time of a RAM chip—the

amount of time it takes for the chip to deliver a unit of data once the request is made—is the simplest means of determining how quickly RAM can deliver data. The nanosecond rating on a chip specifies its access time. A chip rated at 150 ns. has a 150-ns. access time, one rated at 100 ns. has a 100-ns. access time, and so on.

Access time is only one component of a RAM chip's total cycle time. The rest is "precharge time." After a RAM chip is accessed, a RAM location requires a cer-

**Optimum performance
in a PC is related to the
interaction between
the CPU and RAM.**

tain amount of time—usually a figure that equals about 80 percent of the access time—to precharge before it can be read again. Remember that for a CPU to run with zero wait states, a RAM chip's rated access time must be less than the CPU's memory access time. With precharging figured in, a CPU will need roughly a two-fold margin between its memory access time and a RAM chip's raw access time in order to operate without wait states.

Figure 1 lists the memory access times for a number of Intel microprocessors running at different clock speeds. Inexpensive

200-ns. RAM chips are more than adequate for a 4.77-MHz PC, even though the total cycle time for a 200-ns. RAM chip is typically around 350 ns. A 286 PC requires faster, 100-ns. RAM, and with the 386, even 100-ns. RAM isn't fast enough for zero-wait-state operation.

Because fast memory subsystems are very expensive, hardware designers have come up with a number of memory architecture schemes to squeeze the most out of conventional DRAM (dynamic RAM) and reduce the number of wait states that would be required with a straight-through architecture. With an interleaved RAM architecture, consecutive memory addresses are divided between two memory banks. A memory location in one bank can be precharging while a memory location in the other bank is being accessed.

With page-mode RAM, RAM is divided into pages a few thousand bytes in length and outfitted with special circuitry that permits consecutive memory access within a page to be performed with no wait states. Static RAM caches offer the greatest performance paybacks of all: the contents of slower DRAM are cached in much faster (and more expensive) static RAM so that consecutive memory accesses can occur at zero wait states. Static RAM caching is now used on most 386 machines that run at 20 MHz and above—one exception being IBM's 20-MHz Model 70, which uses page-mode RAM.

Will faster RAM result in a faster computer? No. If you're already operating with zero wait states, adding faster RAM chips won't speed up the CPU. By the same token, if the architecture of your system does impose wait states on the CPU, replacing older, slower RAM chips with faster ones won't eliminate the wait states. Wait states are hardwired into the circuitry that surrounds the CPU. Eliminating them usually means swapping out the entire motherboard.—Jeff Prossie

ASK THE TUTOR

The Tutor solves practical problems, explains points of general interest about using your hardware and software more productively, and answers basic questions about DOS and systems in general. To see your questions answered here, drop a line to Tutor, *PC Magazine*, One Park Avenue, New York, NY 10016, or upload them to PC MagNet (see the "By Modem" sidebar in the Utilities column). We're sorry, but we cannot answer questions personally. ■



COMMON CPU MEMORY ACCESS TIMES

Processor	Clock Speed (MHz)	Access Time (ns.)
8086/8088	4.77	840
8086/8088	8	500
8086/8088	10	400
80286	6	333
80286	8	250
80286	12	167
80386	16	125
80386	20	100
80386	25	80
80386	33	60

Figure 1: The table above lists the memory access times for a number of Intel microprocessors running at different clock speeds. Faster CPUs require proportionally faster RAM chips in order to operate without wait states.

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by
Frank J. Derfler, Jr.

Connectivity Clinic

INVESTING IN THE FUTURE

I just read that IBM will provide an upgrade to its PS/2 Model 70 to turn it into a 486-based computer. They claim it will run some programs three times faster than a 33-MHz 386-based PC. We intend to upgrade to NetWare 386 soon. Should we plan to upgrade to a 486 server, too?

Carol M. Scott
Boston, Massachusetts

PC It looks as if the market is initially going to ask for a premium of \$3,000 to \$4,000 for a 486-based computer over a similarly configured 386 machine. NetWare 386 is designed to be 486-aware, but there are several basic investments you should make to improve network performance before paying the bonus for a 486 processor.

The primary bottleneck in any network is the server's hard drive. You need to install a fast hard disk with plenty of capacity. My favorite drives for NetWare servers come from Core International (telephone (407) 997-6055). Core makes it easy to integrate large drives in a Micro Channel/NetWare server. We run Core drives with nearly 1.5 gigabytes of storage at PC LAN Labs, and they are fast and reliable.

The next investment to make is in RAM for your NetWare server. The impact that the amount of RAM has on server performance varies with the application, but if you have 1MB of RAM for every 100MB of disk storage, you'll have optimal performance for the heaviest workloads. Add to this an extra 512K of RAM for the software.

After the drive and its RAM cache retrieve data, performance can falter in the busy connection between the network interface card and the file server. Before upgrading your processor, make sure data isn't backing up at the interface card. If you use an AT-bus structure, you should get the fastest 16-bit interface card for the server you can find. For Ethernet networks, we like the G/Ethernet adapter from Gateway Communications (tele-

■ **INVESTING IN THE FUTURE:** Busy networks should plan to upgrade to a 486 server, but not without making some basic investments first.

■ **OPTIMIZING NETWORK DRIVES:** Although file fragmentation is less of a problem under NetWare than under DOS, it still pays to clean up your drives.

■ **AN EASIER WAY TO TEST NETWORK CABLES:** Here's a portable wiring tester that does it all.

■ **SHARING MODEMS:** Managing pooled modems is easy if you have the right equipment.

■ **USING PROMPT IN LOGIN SCRIPTS:** Here's a simple way to distinguish users on a LAN.

phone (714) 553-1555) with either 16-bit AT or Micro Channel adapters. In the ARCnet world, Pure Data is our choice for both 16-bit AT and Micro Channel adapters (telephone (416) 731-6444.)

A responsive server running under a heavy network load benefits from using a network interface card with a 32-bit data interface. Unfortunately, not many manufacturers make cards with a 32-bit interface—mainly because of confusion over which standard to follow. IBM makes a 32-bit token-ring card for its Micro Channel PS/2 machines, but we don't know of a 32-bit Ethernet card for Micro Channel systems. The 32-bit EISA bus is still not-

ing but a ghostly specification.

Our recommendation is that people with a busy Novell or LAN Manager network should budget for a 486-based machine as a server in the next 24 months. But don't pay the premium for the processor today if you haven't made the basic investment in a fast hard drive, sufficient RAM memory, and a capable network interface card for the server.

OPTIMIZING NETWORK DRIVES

I manage a 286-based Novell network and I'd like to decrease the access time for large files. I know you can't use regular disk optimizer software to arrange the data on the drive because NetWare doesn't use File Allocation Tables as DOS does. Does NetWare write files as noncontiguous fragments, or is it not necessary to use an optimizer for drives running under NetWare?

Kenneth Parker
Fort Collins, Colorado

PC When NetWare creates a new file, it looks first for "virgin" disk space. But as the file grows, or on drives where all the space has been used once, pieces of the file can be written all over the disk. However, file fragmentation isn't as damaging to performance under NetWare as it is under DOS because techniques such as read-ahead, caching, and elevator seeking handle fragmented data with greater efficiency than DOS.

Ontrack Computer Systems (telephone (612) 937-1107) tells us that while it currently doesn't have a disk optimizer among its NetWare utilities, it would like to hear from people who would be interested in such a product. The engineers note that an optimizer would have to operate with the server down because NetWare doesn't give an external process the ability to physically relocate or directly manipulate files.

Ontrack couldn't quantify the performance increase you might enjoy by putting the data in contiguous physical form, but many of its customers report an improvement when they save all their data in a file-

Connectivity Clinic

by-file archive, reformat the drive using Ontrack's *Disk Manager-N*, and then restore the data. When file-by-file restoration is done to a fresh drive, the data is physically contiguous. In the LAN Labs, we think that using this process to clean up a drive is a good practice.

AN EASIER WAY TO TEST NETWORK CABLES

I support approximately 20 large and small networks on a university campus. Almost all of these networks were installed by maverick instructors, department heads, and students. The wiring includes every kind of twisted-pair and coaxial cabling. The quality of the wiring ranges from superb to awful.

Our electronics lab has a time domain reflectometer we can use to check out some of the cabling, but the thing is too difficult to lug around and set up. Is there something like a volt ohm meter for network wiring that is more portable?

David Jansen
Boston, Massachusetts

PC My first love is hardware, so I always look for test equipment at trade shows. By far the best network cable tester I've found comes from Beckman Industries in San Diego, California (telephone (619) 495-3200). Its TMT-1 (Transmission Medium Tester) will test all kinds of coaxial and twisted-pair wiring including the several kinds of IBM token-ring cables. Some of its features include the ability to find transposed pairs on telephone-type wires, measure average or weighted band noise levels, and find pinpoint shorted or open coaxial cable connections down to the inch. It will even provide the characteristic impedance of a cable, so you can tell if that stuff sticking out of the wall is for Ethernet, IBM 3270, or a television.

The TMT-1 fits in the palm of your hand and comes in its own shoulder bag loaded with all the connectors, terminators, and adapters you'll ever need. At a list price of \$3,200 it isn't inexpensive, but it is a good investment for anyone with a large wiring system.

SHARING MODEMS

The modem-management features of products such as Crystal Point's *LineLock*, cited in your article of May 16, 1989, caught

my eye. We want to install a bank of shared modems, but not on a LAN. We need software that will monitor who uses the modems and what numbers they call. Are there products available to manage shared modems?

Gary Vallery
Baton Rouge, Louisiana



The good news about software designed to manage pools of modems is that it works well. The bad news is that each company's software product works only with the modems produced by that company. This is an old but effective technique for capturing clients, and it means you have to make the initial selection of your vendor very carefully. Taking caution seems particularly wise this year when three major modem companies have either been restructured or gone out of business.

Several modem companies market MS-DOS software that manages banks of shared modems and reports on their activity. One very flexible package is Universal Data Systems' *GlobalView*. *GlobalView*, which runs under *Microsoft Windows*, collects operational information every 10 seconds from as many as 512 modems connected to dial-up lines.

You can sort the collected data, save it in disk files, and generate printed reports. The software lets you set alarms on specific parameters, and *GlobalView* will display a visual representation of each modem's status on your screen.

One of the best things about this product is that Motorola owns Universal Data Systems. The company is rooted in the bedrock of the modem business and is not likely to be moved by the breezes blowing through the industry. Contact Universal Data Systems at (205) 721-8000 for more information.

USING PROMPT IN LOGIN SCRIPTS

I recently ran into a situation on my Novell network where I had to make only a single file in a subdirectory of many files inaccessible to certain users. Novell said it couldn't be done, so I created the following procedure:

■ Include the line SET PROMPT = \$L\$P\$G in the login scripts of less privileged users. Their prompts will look something like <F>A>.

■ Include the line SET PROMPT = \$P\$G in the login scripts for the other users. These users will have the familiar F> as their system prompt. Now you can tell users

apart just from their system prompt.

■ Include the following code in your Quick-BASIC programs to read the system prompt:

```
I = 1
DO WHILE ENVIRON$(I) <> ""
IF ENVIRON$(I) = "PROMPT=$L$P$G"
THEN
GOSUB LOW_LEVEL_USER_ONLY
ENDIF
I = I + 1
LOOP
```

This routine allows your programs to read the DOS environment strings to determine who is performing a task. It is a useful way to keep certain people from using a particular file. For example, I include it as the first routine in an invoicing program to identify unwanted users. I then dump them to DOS or CHAIN them to another .EXE file. I also use it to allow only one user to reset month-to-date sales figures and close accounting periods automatically without the danger of two computers doing the same procedure on the same file erroneously.

This procedure would work for other operations within your programs that you want only certain users to perform, and you could also use other DOS environment strings as key identifiers if more security is needed.

Doug Tennant
Baltimore, Maryland



This procedure works because *NetWare* can give each user a unique set of login commands. The system isn't secure since anyone can change his or her prompt from the command line. But if you set a variable in a particular way in the environment and then test for that setting, it is more difficult to fool the system.

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Everex PSII w/2 MG	\$695
Orchid Tiny Turbo	\$219
Orchid Extra	\$259
Intel Above Board 286+	\$379
Irma Board III	\$399
AST 5251-II Plus	\$529

CHIPS

64K Ram Chips	9 for \$20
256K Chips/1 MG Chips each	\$5/\$15
1 MB Simms	\$149
Compaq 386 1 MB	\$399
Compaq 386 4 MB	\$999
8087-3-2	\$99/\$129
80287-6MHZ/8MHZ	\$149/\$199
80287-10MHZ	\$225
80387-16/80387-20	\$319/\$359
80387-25/80387-33	\$469/\$595
80C287-A	\$275

SOFTWARE

D Bass III Plus	\$409
D Bass IV	\$449
Harvard Graphics	\$275
IBM Displaywrite IV	\$279
Logitech Mouse	\$74
Lotus 123	\$299
Managing Your Money	\$125
Microsoft Mouse	\$99
Microsoft Word	\$219
Mouse Systems Mouse	\$79
Multimate Adv. II	\$279
R Base for DOS	\$439
Symphony	\$419
Ventura Desktop Publ.	\$489
Word Perfect 5.0	\$219

MODEMS & FAXES

Hayes 1200/2400	\$249/\$369
Everex 1200/2400	\$79/\$149
Everex 2400 External	\$199
US Robotics 2400 Int.	\$169
Sharp FO-220 Fax	\$699
Sharp FO-300 Fax	\$799
Sherp FO-330 Fax	\$999

DRIVES & TAPES

Ext. 5 1/4" for PSII ..	\$169	SEAGATE HARD DISKS	
Ext. 1 1/2" for PSII ..	\$199	20 MB for XT (ST225) ..	\$259
Toshiba 3 1/2" 720K ..	\$69	30 MB for XT (ST238) ..	\$269
Toshiba 3 1/2" 1.44 ..	\$99	40 MB 3 1/2" (157) ..	\$389
Inwin 20 MB Tape	\$339	40 MB for AT (ST251-1) ..	\$339
Inwin 40 MB Tape	\$449	80 MB for AT	\$589

IOmega

Bernoulli Box II 5 1/4" 20 MB Int. w/card	\$949
Bernoulli Box II 5 1/4" 44 MB Int. w/card	\$1159
Dual 20 Ext. w/card	\$1769

PLUS

Hard Card 20 MB	\$529	CONNOR HARD DRIVES	
Hard Card 40 MB	\$649	40 MB	\$499
		100 MB	\$799

VIDEO BOARDS

ATI EGA Wonder 800	\$219
ATI VGA Wonder	\$259
ATI VGA Wonder 512	\$319
Everex EGA	\$139
Hercules Graphics Plus	\$179
Hercules VGA	\$199
Orchid Pro Designer	\$249
Paradise Autoswitch 480 ..	\$149
Paradise VGA	\$199
Paradise +18	\$239
Paradise Professional	\$299
Vega VRAM VGA	\$409
Vega VGA	\$239

MONITORS

NEC

Multisync IIA	\$499
Multisync IIID	\$649
Multisync IVD	\$1125
Multisync XL, 19"	\$2049

MITSUBISHI

EGA/Diamond Scan	\$349/\$499
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PRINCETON

Ultrasynd	\$499
Ultra 16	\$679

SAMSUNG

Color/EGA	\$229/\$329
Multisync	\$429

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Epson FX-850

- Narrow-carriage 9-pin, dot-matrix printer
- SmartPark™, a unique Epson paper-handling innovation, lets you switch from fanfold to single sheets or envelopes without removing hardware or paper
- With a standard push feed tractor and single sheet friction feed, the FX-850 can handle virtually any type of paper as well as envelopes
- The FX-850 prints 290 characters per second (CPS) in high-speed draft mode (10 CPI); 54 CPS in Near Letter Quality mode (12 CPI)



Epson FX-1050

- Wide-carriage 9-pin, dot-matrix printer
- SmartPark™, a unique Epson paper-handling innovation, lets you switch from fanfold to single sheets or envelopes without removing hardware or paper
- With a standard push feed tractor and single sheet friction feed, the FX-1050 can handle virtually any type of paper as well as envelopes
- The FX-1050 prints 290 characters per second (CPS) in high-speed draft mode (10 CPI); 54 CPS in Near Letter Quality mode (12 CPI)



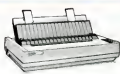
Epson LQ-510

- Epson's 24-pin, dot matrix technology creates true letter quality characters and high-resolution graphics
- Prints 180 characters per second (CPS) in draft mode; 60 CPS in letter quality (12 CPI)
- Epson's SmartPark™
- Exclusive SelectType front control panel offers quick, easy selection of popular typescripts, fonts and pitch



Epson LQ-850

- Epson's 24-pin, dot matrix technology creates true letter quality characters
- Epson's SmartPark™
- Exclusive SelectType front control panel offers quick, easy selection of popular typescripts, fonts and pitch
- 264 Characters per second in the high-speed draft mode delivers outstanding productivity
- 88 Characters per second in Letter Quality mode for enhanced, high-resolution characters



Epson LQ-1050

- Epson's 24-pin, dot matrix technology creates true letter quality characters
- Epson's SmartPark™
- 264 Characters per second in the high-speed draft mode delivers outstanding productivity
- 88 Characters per second in Letter Quality mode for enhanced, high-resolution characters
- Exclusive SelectType front control panel offers quick, easy selection of popular typescripts, fonts and pitch



Epson LQ-2550

- 24-pin technology creates superior Letter Quality characters and high-resolution graphics up to 360 dpi

- 7-Color printing capability is standard
- Epson's SmartPark™
- Exclusive LCD SelectType front control panel for easy selection of pre-sets, fonts and printer functions
- 133 Characters per second print speed in Letter Quality mode (12 CPI)
- 400 Characters per second print speed in draft mode (12 CPI)
- Epson LQ ESC/P™ assures software compatibility

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YOU'VE GOT A LOT OF COMPANY.™**

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CompuAdd written all over them.



challenged our engineers.

A simple task: don't just make them prettier, make them better. When you consider CompuAdd's reputation, they had no easy task.

Added functions.

The design team chose to downsize and build five new functions into each new motherboard: a dual IDE hard drive interface, a dual diskette drive controller, two serial ports, a parallel port and a game port interface. These built-in functions reduce by two the number of expansion cards users typically purchase. The result to you: increased functionality and reliability and a smaller footprint.

Maintains flexibility.

What wasn't downsized? Expansion card flexibility and drive configuration options. Every new low profile CompuAdd system is five-card expandable. Up to three full-size and two half-size cards can be added. Users retain maximum flexibility in diskette and hard drive configurations, including the freedom to specify two half-height hard drives.

Customer driven, by design.

We're proud to present our design team's response to the challenge: a full line of CompuAdd personal computers that deliver greater value than ever before.

CompuAdd's No-Risk Guarantee

1. 30-Day No-Questions-Asked Guarantee

Every hardware product and every other accessory CompuAdd will give complete satisfaction. If not, return it in the original packaging, freight and insurance prepaid, within 30 days of purchase for a full refund of the list price. Consumables, items, opened software, video, tapes, and shipping costs not refundable.

2. Toll Free Technical Support • One-Year Limited Warranty • Free Return Freight for Mail Order Repairs

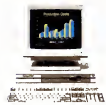
If you experience a problem with anything you purchase from CompuAdd, call 800-666-1872 weekdays from 9:00am to 7:00pm, CST. Our technical support staff will be happy to assist you with any hardware or software difficulty. If we cannot resolve a hardware problem over the phone, we will assign you a return authorized technician (RMA). We ship the equipment to our local Service Center promptly and incur no charge. We will repair or replace the product (at our option) without cost to you and pay for the return freight. We may also carry the product into one of our North American Superstores where our repair staff can assist you on the premises. Call 800-666-1872 for a copy of CompuAdd's complete warranty.

3. No-Charge 90-Day Express Part or Product Exchange for Mail Order Customers

If a problem affects the service or operation of a component purchased as a CompuAdd system (CPU, monitor or keyboard) in the first 90 days, we will determine the cause and, if needed, ship a replacement part or product within 48 hours (depending on availability of parts, via Federal Express® standard air—at our expense).

4. Onsite Service Available

Onsite service is available within 500 Miles/Hours. Toll-free service areas nationwide on all CompuAdd systems. The CompuAdd 216 and 212 series systems come with FREE onsite service during the initial one-year warranty period. Purchases of other CompuAdd systems may buy a year of onsite service at the time of purchase. Extended two and three year warranties are also available on all CompuAdd systems. A negotiated service agreement must be received prior to onset of any onsite services. Call 800-666-1872 or visit a CompuAdd Superstore for more information.



\$595
64700

810 Monitor and Hard Drive Options

	MGA	CGA	CVGA
No Hard	64701	64706	64711
Drive	8690	8620	81130
20MB	64702	64707	64712
40MB	8670	81110	81610
40MB	64703	64708	64713
(15mm)	81129	81590	81560

The CompuAdd 212

Far and away the best value on the market in a 286 PC AT™ class system, the 212 can handle the toughest MS-DOS-based software at 12MHz.

- 80286® processor running at 12MHz
- 512KB RAM expandable to 4MB on motherboard
- 0 wait state page-mode memory
- Built-in dual IDE hard drive interface
- Built-in dual diskette drive controller
- Built-in parallel port and two serial ports
- Built-in game port interface
- Three full-size 16-bit and two half-size 8-bit expansion slots
- 80287™ math coprocessor support
- Choice of 5.25" 1.2MB or 3.5" 1.44MB diskette drive
- Real-time clock
- 101-key enhanced keyboard
- 145-watt power supply

Monitor optional.

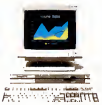
The CompuAdd 810

Perfect for word processing, spreadsheet and database applications, the 810 is also an economical alternative for LAN stations that don't need 286 or 386 architecture.

An unbeatable value:

- NEC V20® processor rated at 10MHz
- 640KB RAM with parity checking
- Built-in dual IDE hard drive interface
- Built-in dual diskette drive controller
- Built-in parallel port and two serial ports
- Built-in game port interface
- Three full-size and two half-size PCXT™ expansion slots
- 8087™ math coprocessor support
- 5.25" 360KB diskette drive
- Real-time clock
- 101-key enhanced keyboard
- 145-watt power supply

Monitor optional.



\$895
64730

212 Monitor and Hard Drive Options

	MGA	EGA	CVGA
20MB	64731	64736	64741
(15mm)	81590	81709	81709
40MB	64732	64737	64742
(15mm)	81609	81649	81650
80MB	64733	64738	64743
(15mm)	81729	82079	82160

The CompuAdd 216

Our new 216 meets the speed and power needs of OS/2™ and SCO™ XENIX. All of the same features as the CompuAdd 212 with a blazing processing speed of 16MHz.

Monitor optional.



\$995
64776

216 Monitor and Hard Drive Options

	MGA	EGA	CVGA
40MB	64777	64937	64782
(20mm)	81590	81949	82030
80MB	64778	64938	64783
(15mm)	81609	81979	82060
110MB	64779	64939	64784
(15mm)	82029	82379	82460

Call Today! And discover the new standard for corporate and personal computing.

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of CompuAdd computers.

The CompuAdd 316s

Power packed on a small footprint, the 316s opens the door to 386 software at an exceptionally low price. Like all 300 series systems, the 316s comes with one year of **FREE** onsite service.

- 80386SX processor running at 16MHz
 - 1MB memory expandable to 4MB on motherboard
 - 0 wait state page-mode memory
 - Built-in dual IDE hard drive interface
 - Built-in dual diskette drive controller
 - Built-in parallel port and two serial ports
 - Built-in game port interface
 - Three full-size 16-bit and two half-size 8-bit expansion slots
 - 80387SX math coprocessor support
 - Choice of 5.25" 1.2MB or 3.5" 1.44MB diskette drive
 - Real-time clock
 - 101-key enhanced keyboard
 - 145-watt power supply
- Monitor optional.



\$1495
64787

316s Monitor and Hard Drive Options

	MGA	EGA	CVGA
40MB (27mm)	64788	64943	64793
80MB (27mm)	\$2999	\$3448	\$2538
80MB (5 1/4")	64789	64944	64794
110MB (5 1/4")	\$2539	\$2879	\$2789
110MB (11mm)	64790	64945	64795
	\$2539	\$2879	\$2789

The CompuAdd 220

"If what you want is a fire-breathing DOS machine, the CompuAdd (220) is a good choice." *PC Magazine* (4/11/89)

- 80286 processor running at 20MHz
- 1MB RAM expandable to 5MB on motherboard
- 0 wait state page-mode memory
- Desk enclosing software
- LIM 4.0 support
- ROM shadowing into faster DRAM
- Dual IDE hard drive interface
- Dual diskette drive controller
- Built-in parallel port and two serial ports
- Six available expansion slots
- 80287 math coprocessor support
- 40MB IDE hard drive
- Choice of 5.25" 1.2MB or 3.5" 1.44MB diskette drive
- Monochrome VGA monitor
- 16-bit VGA video adapter card
- 101-key enhanced keyboard
- INTEGRATOR™ software



\$2449
64799

220 Monitor and Hard Drive Options

	NEVIA	CVGA
40MB	64799	64805
80MB	\$2449	\$2899
80MB (5 1/4")	64800	64806
110MB	\$2879	\$3029
110MB (5 1/4")	64801	64807
110MB (11mm)	\$2879	\$3129
110MB	64802	64808
	\$3329	\$3679

FREE technical support and onsite service are included in your purchase of a CompuAdd 220 system. It's just part of being a completely customer driven company.

CompuAdd's Full Profile Systems Are Packed With Speed And Power.

From the beginning, CompuAdd has been a new kind of technology company, intent upon building better machines measured against one ultimate standard—better value for the dollar.

Now we offer fully configured 386 systems. The Big Guys. With all the hardware and speed you need to handle the toughest business problems. As *PC Magazine* wrote about them, "The inhouse engineered (320 and 325) are a big step in the right direction" and "CompuAdd's (316) is a good example of value you can get for dollars spent by mail." Call today for prices and capacities.



CompuAdd's New Career Starter Kit™

At the heart of the new Career Starter Kit is our most affordable XT-compatible workhorse, the new CompuAdd 810, with its sleek, small footprint design. Surrounding the 810 is a package that contains everything you need to start computing. Monitor. Printer. Cables. Operating and applications software. Even paper and blank diskettes.

\$899
64716

- CompuAdd 810 computer (XT-compatible)
 - NEC V20 processor rated at 10MHz
 - 640KB RAM with parity checking
 - Built-in dual IDE hard drive and game port interfaces
 - Built-in dual diskette drive controller
 - Built-in parallel printer port and two serial ports
 - Three full-size and two half-size XT expansion slots
 - 8087 math coprocessor support
 - Monographics monitor and adapter
 - Star Micronics NX-1000™ printer and cable
 - 5.25" 360KB diskette drive
 - CompuAdd MS-DOS v4.01 and GW-BASIC™ software
 - New Spinaker's Eight-in-One™ integrated software
 - Real-time clock
 - 101-key enhanced keyboard
 - Computer paper and ten blank diskettes
- Color monitor optional.

Career Starter Kit Options

	MGA	CGA	CVGA
No Hard Drive	64716	64721	64726
40MB	\$899	\$1039	\$1339
80MB	64717	64722	64727
	\$1179	\$1319	\$1619
110MB	64718	64723	64728
	\$1329	\$1469	\$1769

CompuAdd's New Professional Starter Kit™

Looking for the value, savings and convenience of a package purchase? Unwilling to sacrifice quality, flexibility, reliability or technical support when you invest in a business computer? Look no further.

Computerize Your Business For **\$1495**
64747

- CompuAdd 212 computer (AT-compatible) with 40MB hard drive
 - 80286 processor running at 12MHz
 - 512KB RAM expandable to 4MB on motherboard
 - 0 wait state page-mode memory
 - Built-in dual IDE hard drive and game port interfaces
 - Built-in dual diskette drive controller
 - Built-in parallel printer port and two serial ports
 - Three full-size 16-bit and two half-size 8-bit expansion slots
 - 80287 math coprocessor support
 - Monographics monitor and adapter
 - Panasonic 1180 printer and cable
 - Choice of 5.25" 1.2MB or 3.5" 1.44MB diskette drive
 - CompuAdd MS-DOS v4.01 and GW-BASIC software
 - CompuAdd INTEGRATOR productivity software
 - Real-time clock
 - 101-key enhanced keyboard
 - Computer paper and ten blank diskettes
- Color monitor optional.

Professional Starter Kit Options

	MGA	EGA	CVGA
40MB	\$1495	\$1645	\$1895
80MB	64748	64753	64758
	\$1995	\$2295	\$2545

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Video Combos



Color makes charts and graphs easier to read and our **EGA combo** makes adding color video to your system easy on the budget. Features 14" (13" viewable) EGA color monitor and EGA-480 card. Provides 640x480 resolution, 0.31mm dot pitch, and 16 out of a possible 64 colors. **\$489**

Flat Screen Monographics Combo 12" monitor, tilt and swivel base, monographics adapter card. \$1700 **\$139**

Video Graphics Array (VGA) Combo 14" (13" viewable) analog color monitor and a CompuAdd VGA graphics card. \$1704 **\$579**

Super VGA Combo includes the Mitsubishi Diamond Scan 14" (13" viewable) color VGA monitor and a CompuAdd 16-bit VGA card. \$1706 **\$745**

Monitors

Color CGA 14" analog monitor offers a 14" (13" viewable) display with a 0.31mm dot pitch and 640x480 resolution. \$1072 **\$379**

NEC Multisync 2A Super VGA color analog monitor 14" (13" viewable) screen and 0.31mm dot pitch provides 800x600 resolution. \$1306 **\$510**

Seko Instruments 14" monitor flat, flat Trinitron™ screen with up to 1024x768 resolution, 0.26mm dot pitch, and one electron gun technology for intense colors. \$602 **\$595**

Graphics Cards

CompuAdd 16-bit VGA adapter card provides up to 800x600 resolution, with 16256K colors. \$4333 **\$259**

Orchid ProDesigner VGA Plus features 512KB memory with up to 1024x768 resolution, and 16256K colors. \$4333 **\$415**



"One of the giants of mail order, CompuAdd offers quality hard disks, competitive prices, excellent documentation, and courteous service backed up by a 30-day trial period and money-back guarantee."

—PC Magazine, Editor's Choice for Mail Order Hard Disks, June 27, 1989

Hard Drives



Take advantage of the convenience and greater flexibility provided by the speedy **40MB Seagate™** (28ms) AT-compatible hard drive. Every CompuAdd hard drive kit includes the drive, connecting cable, mounting hardware, manual, and FREE **PC-FullBak™** disk backup software. **\$399**

XT Class Hard Drives

20MB Seagate (65ms) half-height, with controller. \$700 **\$279**
30MB MiniScribe™ (65ms) half-height, with RLL controller. \$7100 **\$299**
30MB Seagate (65ms) half-height, with RLL controller. \$7101 **\$299**
40MB Seagate (40ms) half-height, with controller. \$7100 **\$425**
60MB MiniScribe (61ms) half-height, with RLL controller. \$7100 **\$389**

AT Class Hard Drives

20MB Seagate (65ms) half-height drive. \$7100 **\$219**
40MB MiniScribe (61ms) half-height drive. \$7101 **\$319**
40MB Seagate (28ms) full-height drive. \$7101 **\$629**

ESDI Hard Drives

90MB CDC (18ms, 10MHz) half-height drive. \$7452 **\$399**
150MB CDC (18ms, 10MHz) full-height drive. \$7452 **\$1189**
320MB MiniScribe (18ms, 10MHz) full-height drive. \$7454 **\$1699**
320MB CDC (14.5ms, 10MHz) full-height drive. \$7452 **\$1789**
630MB CDC (14.5ms, 15MHz) full-height drive. \$7452 **\$2899**

XT FlashCards

FlashCard-30™ 20MB MiniScribe (65ms). \$7006 **\$299**
FlashCard-30™ 30MB MiniScribe (65ms). \$7104 **\$329**

NEW! HardCache/ESDI™ Controller



The new CompuAdd HardCache/ESDI Controller reduces system access time to cached data to less than 0.5ms—up to 30 times quicker than even the fastest hard drive! Perfect for any network, CAD/CAM, or graphics application.

Features automatic system self-configuration, programmable precode, and automatic cache set definition. Base configuration 256KB. Upgrades require 100ns SIMMs.

NEW! ESDI 10MBit controller. \$6517 **\$180**

\$495

Diskette Drives



Our double-sided, high-density 3.5" 1.44MB diskette drive is an exceptional bargain.

\$89

5.25" Diskette Drives

360KB XT-compatible (black). \$5300 **\$89**
360KB AT-compatible (gray). \$5302 **\$89**
1.2MB AT-compatible (gray). \$5350 **\$89**

3.5" Diskette Drives

720KB XT-compatible (black). \$5302 **\$89**

Tape Backup Systems

40MB internal tape backup for AT-compatibles. \$5005 **\$329** (Regularly \$350)
60MB internal tape backup for XT- or AT-compatibles. \$5006 **\$359**

Math Coprocessors

80287-8 math coprocessor (8MHz). \$6051 **\$219**
80287-10 math coprocessor (10MHz). \$6052 **\$249**
80387-20 math coprocessor (20MHz). \$6077 **\$439**
80387-25 math coprocessor (25MHz). \$6078 **\$459**

Input/Output Cards

I/O Card for XT-compatibles with serial port, parallel port, game port, and clock/calendar with battery backup. \$6001 **\$55**
I/O Card for AT-compatibles with serial port, parallel port, and game port. \$6002 **\$49**

Memory Cards

AT-compatible EMS card with 0KB expandable to 2MB. \$1002 **\$119**
Intel Above™ Board PLUS with 512KB expandable to 2MB for XT- and AT-compatibles and PS/2™-30. \$1010 **\$419**

Multifunction Boards

AT Multifunction board with 0KB expandable to 1.5MB, serial port and parallel port. \$6010 **\$89**
XT Multifunction board with 384KB RAM, serial port, parallel port, game port, clock/calendar with battery backup, and utility software. \$6710 **\$199**

Input Devices



The CompuAdd Optical Mouse features 200dpi resolution, Dr. Halo III™

point software, mouse pocket, and pad. (Regularly \$55) **\$44.99**

Microsoft® Bus Mouse is an optical/mechanical mouse with bus interface. \$5001 **\$119**

Hewlett-Packard ScanJet Plus Desktop Scanners scans photographs, drawings, or printed material into your desktop publishing environment. Provides high resolution of up to 600dpi. Requires interface kit. \$6007 **\$1095**
Hewlett-Packard ScanJet Plus Interface Kit for XT- or AT-compatibles. \$6008 **\$395**

by design.

Uninterruptible Power Supplies



American Power Conversion uninterruptible power supplies provide five to 65 minutes of precious operating time (depending on your configuration) for safe exiting of software applications. Features noise filter and surge suppression, maintenance-free battery and charger, overload protection, and two-minute warning before final shut down. 200 [300, 360] watts maximum.

Model 450AT
for PC AT, PS/2-40
and 386 systems.

Model 520ES for file servers.
40711 \$499

\$425

Power Supplies

150-watt XT-compatible replacement power supply. 40700 \$59
200-watt AT-compatible replacement power supply. 40605 \$119

Modems

Internal Modems

1200 baud ¼-card internal modem with software. 45500 \$69
2400 baud internal modem with software. 45552 \$119
Hayes 2400B 2400 baud ¼-card internal modem. 45552 \$409
Everex Evercom™ 2400 baud ¼-card internal modem with software. 45552 \$149

External Modems

2400 baud external modem. 45457 \$129
Everex 2400 baud external modem. 45475 \$179

FAX Boards

Internal JT FAX board (4800 bps). 56107 \$249
Internal JT FAX board (9600 bps). 56109 \$549

Printers



HP auth-

Enhance the art of producing publication-quality printed documents with a Hewlett-Packard LaserJet Series II. Features 512KB RAM, toner cartridge, a 200-sheet letter-size input tray, and RS-232C/parallel interface.

\$1749
56000

Near-Letter Quality

Panasonic™ 1180 (11" carriage, 192 draft/38 NLQ). 56380 \$195
Epson™ LX-810 (11" carriage, 180 draft/30 NLQ). 56390 \$199
Epson FX-1060 (15" carriage, 250 SuperDraft/54 NLQ). 56391 \$469
Okidata Microline™ 321 (15" carriage, 300 draft/63 NLQ). 56390 \$465

Letter Quality

Panasonic 1124 (11" carriage, 192 draft/63 NLQ). 56389 \$339
Okidata Microline 300 (11" carriage, 270 draft/90 NLQ). 56391 \$469
Panasonic 1124 (15" carriage, 240 draft/80 NLQ). 56389 \$559
Okidata Microline 301 (15" carriage, 270 draft/90 NLQ). 56392 \$649

Epson LQ-1060 (15" carriage, 264 draft/66 NLQ). 56393 \$775

Laser Printers

Hewlett-Packard LaserJet Series III. 56002 \$2999
QMS-PS™ 810 Adobe® PostScript® laser printer. 56021 \$3949

Printer Accessories

QMS Big Bin sheet feeder with 1000-sheet capacity. 56000 \$635
QMS UltraScript™ PC adds the powerful flexibility of PostScript printing to practically any printer. 56000 \$138
LaserJet Series II and III toner cartridge, black (prints 4000 pages). 56000 \$89.10

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CompuAdd—one of the fastest growing, privately held companies in the United States—began this year with 15 Superstores. This month there will be 70. By year end, we expect to have 80.

Our rapid growth and exponential sales tell us that price and performance remain an unbeatable combination for CompuAdd customers. CompuAdd Superstores offer the convenience of local sales and service at our heart-stopping, mail order prices.



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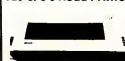
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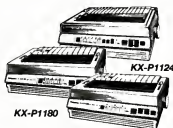
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HOW TO SUCCESSFULLY BUY THROUGH MAIL ORDER AND PROTECT YOUR RIGHTS

Mail order sales are governed by rules of the Federal Trade Commission (FTC) and various state laws. These guidelines are published as a service to you. Remember, the many vendors advertising in this section are eager to serve your needs.

FTC rules say:

1. The seller must ship your order within 30 days of receiving it, unless the advertisement clearly states it'll take longer.
2. If it appears that your order will not be shipped when promised, the seller must notify you in writing in advance of the promised date, giving a definite new date, if known, and offering you the opportunity to cancel the order with a refund or consent to a definite delayed shipping date or an indefinite delay.
3. The seller's notice must contain a stamped self-addressed card or envelope with which you can indicate your preference. If you don't respond to this notice, the seller may assume you agree to the delay, but must either ship or cancel your order within 30 days after the original shipping date.

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5. In the event that the item you ordered is unavailable, the seller may not send you substitute merchandise without your express consent.

TIPS WHEN ORDERING

1. When ordering by mail, State precisely what merchandise you want, specifying details such as model, make, size, component parts, etc.
2. Confirm the price and expected delivery date as stated in the ad. Indicate whether you will accept a substitute product if the item you ordered is unavailable, and, if not, that your payment should be returned.
3. Don't send cash, you will have no record of payment if a problem arises, and.
4. Keep a copy of your order and all other correspondence with the seller. Your records should include the company's name, address and phone number; a description of the item ordered; your cancelled check or a copy of the money order; record of the date you mailed the order, or the time and date of your conversation, and the name of the person you talk with; and any sales slips and shipping receipts.
5. Ask about servicing and refund return policies and with whom you should correspond if there is a problem.

IF YOU HAVE PROBLEMS
1. If you have not received your

- order as promised or if the item is defective, immediately notify the seller in writing referring to your order by description, price, date, as well as by account number and order number, if available. Make sure you keep a copy of the letter.
2. If you complain by telephone, send a follow-up letter to confirm what was said.
3. If you think the merchandise is defective, reread your product instructions and your warranty carefully to be sure you don't expect features or performance the product isn't designed to give. Then contact the seller for instructions. Don't return it to the seller until you have been instructed to do so.
4. When returning merchandise make sure you keep the shipper's receipt or packing slip, your right to be reimbursed for postal cost is determined by store policy.
5. If you have completely dissatisfied your problem with the seller and are still not satisfied, write to the consumer complaint agency in the seller's state. If you paid for the merchandise by credit card, you may have rights to withhold payment until a Federal law called the Fair Credit Billing Act

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1. To subscribe, set your modem to: 300 or 1,200 bps, 7 data bits, even parity, 1 stop bit and full duplex. Call one of the numbers listed:

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Miami, FL (305) 266-0231

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(Note: After you have become a member, you can locate a local telephone access number, or 2,400-bps service, by typing GO PHONES at the ! prompt.)

2. When you receive a Connect or Carrier Detected message, enter Ctrl-C.
3. At the HOST NAME prompt, enter CJS.

4. At the USER ID prompt, enter 177000, 5000.
5. At the PASSWORD prompt, enter PC*MAGNET.
6. At the Enter agreement number prompt, enter Z10D8921
7. Register your name and enter your VISA, MasterCard, or American Express account number.
8. Your personal User ID number and Password will be displayed at the end of the subscription process. Please record them in a secure place.
9. A new password will arrive in the mail within 10 days to confirm your subscription.

There are no connect charges for PC MagNet during the subscription process.



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■ AFFORDABLE 386/20 POWER

Competition and reduced production costs are two reasons why a 386/20 PC costs up to \$6,000 less than it did a mere two years ago. This review of the 12 most-affordable 386/20 machines available—6 mail-order units and 6 retail-distributed—takes a look at both the benefits and hazards of buying a high-performance PC at a rock-bottom price.

■ LOW-END INTEGRATED SOFTWARE

No longer the no-respect products of the industry, integrated software packages—especially at the market's low end—have been evolving into tools not only for the beginner with a taste for many applications, but also for the "interrupt-driven" manager and the laptop-lugging professional on the road. See comprehensive reviews of *Microsoft Works*, *AlphaWorks*, *PFS:First Choice*, *DeskMate*, and three other under-\$200 packages.

■ PERSONAL TAPE BACKUP

Since hard disk disaster can strike at any time, regular backups are a must to keep from being caught off-guard. But for more protection than floppy-disk-based systems provide, tape systems utilizing DC-2000 minicartridge technology now offer the best solution for personal backup. PC Labs tests 15 tape backup units from companies like Irwin, Mountain, and Alloy that store 40MB to 80MB and more on one quarter-inch cartridge.

■ PAINT PROGRAMS

Device independence and totally scalable drawings give vector-based graphics an edge in PC business applications, but still there are times when nothing but a bitmapped picture will do. Contributing editor Luisa Simone leads this review of four \$100-range programs—including *PC Paintbrush IV* and *Dulux Paint II*—that use the VGA standard to the fullest by allowing users to choose on-screen colors from a hardware palette. ■

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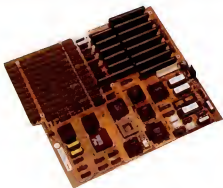
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After Hours

Products for the Leisure Side of Personal Computing

688 Attack Sub: A Challenge for the Mind, A Feast for the Eyes

GAMES
by Tom Unger

Tired of crashing jet fighters? Sick of encounters with sword-happy dwarves? 688 *Attack Sub*, with its superb VGA graphics and emphasis on split-second strategy, might be just what you need. In 688's ten scenarios, you can protect convoys destined for war-torn Europe, fire cruise missiles deep into Soviet territory, or play cat-and-mouse with enemy subs. Wanna be the bad

the command. This nearly human response lends 688 an air of realism not found in other military simulations. Even better, 688 leaves behind the usual stick-figure representations of ships and other targets. Much of what you see as you peer through your periscope is shown as three-dimensional images.

Beware, though: 688's snazzy graphics don't make it easier to pilot a nuclear submarine. Once you lower your periscope and head for the blue depths, you

cellent manual takes you through your first mission. In this baptism of fire, you must sink four Libyan tankers without getting sunk yourself by guided missile destroyers.

From the "Conn," a highly detailed graphic representation of your sub's control room, you use a mouse or the keyboard to access your sub's battle stations. In the Radio Room, you enter a security access code to receive your orders and start the game. You arm and direct your weapons in the Torpedo Room. Weapons are plotted at the Navigation Table, and you listen for targets in the Sonar Room.

At each of these stations, 688 *Attack Sub* displays a detailed top-down map that shows your position, the depth of the surrounding ocean, and a heads-up display of your current course and depth. You can also track the positions and courses of potential targets.

DAMAGE CONTROL

A message line near the bottom of the screen tells you when you're being scanned by another sub, ship, or incoming torpedo. This part of the display also reveals when you've scored or taken a hit, and what kinds of damage you've suffered.

688 is not for those who want a quick-starting shoot-'em-up. This game is *hard*. The first-time commander must cope with a daunting collection of submarine warfare terms: thermal layers, active and passive sonar, band pass filters, towed arrays, contour imaging, and so on.

Targeting your enemies is a little like trying to spot faces in a distant crowd through high-powered binoculars. Make one false move out of your narrow scope of sonar vision and targets suddenly disappear. It takes some time to learn to move silently underwater and to blow your enemy away before he even knows

■ GAMES

The latest Indy Jones flick comes to your PC.

■ GAMES

Software that explores new realms of sight and sound.

■ PERSONAL FINANCE

You could profit from A Banker's Secret.



688 *Attack Sub* uses numerous scanned images, which give the game an atmosphere of tense reality.

guy? Take command of a Soviet sub and work your skills against the capitalist aggressors. You can even pit your deep-water skills against a buddy via modem.

688 makes striking use of scanned images. When you issue an order, for instance, the game's standard top-down map is momentarily replaced by a near-photographic-quality picture of the officer who executes

can't see anything. Somewhere out there—usually in the blind spot right behind your vessel's vulnerable prop—is an Alfa Class Soviet attack sub ready to fire its torpedoes and blow a VW-size hole right through your pressure hull.

While you're mastering the 688's controls and avoiding enemy torpedoes, depth charges, and missiles, Electronic Arts' ex-

you're there. Unlike games you learn right away and put aside a day later, it might take months to successfully complete all of 688 *Attack Sub*'s missions. And, as in real warfare, 688 doesn't provide you with a way to save the game. Once you close the hatch, you're under fire until you you win, quit, or die.

Though 688 was not designed for combatants with low frustration thresholds, it does reward those who don't always need to scream along at full speed. After half an hour's fruitless search, you may just come upon the sub that left you crippled and barely afloat. Imagine your total satisfaction as you coolly pump some high-explosive vengeance into his hide.

After a hard day at the office (and an awful lot of time practicing torpedo-avoidance maneuvers), that kind of satisfaction might just be worth 50 bucks. **List Price:** 688 *Attack Sub*, \$49.95. **Requires:** 256K RAM; CGA, EGA, Tandy 16-color, 256-color VGA, or MCGA; DOS 2.0 or later. Copy protected through documentation. Electronic Arts, P.O. Box 7578, San Mateo, CA 94404-7578; (415) 572-2787.

CIRCLE 420 ON READER SERVICE CARD

After Hours

Indiana Jones Takes His Crusade to Your Desktop

GAMES

by Stephanie K. Losses

Someone should give Lucasfilm Games an award: the Non-Sexist, Non-Gory, Fun-as-All-Get-Out Adventure Game Designer's Trophy. I'll personally contribute my lunch money to have the trophy dipped in gold and established as a yearly prize for the PC game company with the most respect for its customers.

Released in conjunction with the feature film of the same name, *Indiana Jones and the Last Crusade* proves that sophisticated PC games need not be sexist or offensively violent. The action roughly follows the movie's plot as Indy attempts to wrest the Holy Grail from the hands of the vile Nazis. Use your memory to duplicate Indy's path, or go your own way—the game will accommodate either strategy.

Like Lucasfilm's last adventure game release, *Zak McKracken and the Alien Mindbenders*, *Crusade* features a marvelously streamlined word-list interface. This time around the characters can talk to each other, and you decide what they say. As Indy encounters ruffian Nazi guards, you can choose fisticuffs or select one of several rejoinders to

outwit them.

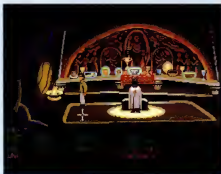
Film critics praised the movie for the inspired pairing of Indy with his grail-obsessed father, and the game preserves the bantering relationship between the two. Once Indy saves his father from the Nazi castle you can switch between the two characters, but you'll discover that all Dr. Jones can do is get Indy deeper into trouble.

The animation in *Crusade* is a real step forward. The characters in Lucasfilm games tended to move in a stiff, Chaplinesque way. No longer. Indiana Jones actually has a manly swagger, and other motions are so fluid that you'll be tempted to replay them again and again. At the end of the game, Indy does a crouch, hop, and somersault move that must be seen to be believed (he even manages to rescue his hat from a huge Slice-O-Matic in the process). I also marvelled at the grace with which he dips the grail into a font of holy water.

Humorous touches abound in the visuals. My personal favorite is the heaving motion of Biff the Nazi's stomach while he puts away a steinful of ale. And the reproduction of a pointillist Seurat painting is a scream. Lucasfilm also goes for laughs by alluding to unseen details of PG-rated

situations. When Indy changes his clothes, the game chastises you for looking and flashes a big CENSORED sign over his body. Likewise when Indy judiciously allows his head to be lopped off. But don't assume that the game has been scrubbed clean of juicy vulgarities. If Indy chooses the wrong grail, the player is treated to a macabre but amusing scene of Harrison Ford rapidly trans-

The Lucasfilm folk are still too fond of mazes for my liking, but at least this time around each hallway has its own distinctive look. And although Lucasfilm is adept at using the Ad Lib card to create top-flight music and sound effects, the soundtrack for the PC's built-in speaker isn't nearly as memorable as the earlier Zak McKracken rap. The medieval church tune that is played in the



In this scene, Indy chooses a grail. The wrong choice could have very painful consequences.

forming into a corpse.

The game and film aren't the only places where you'll find clues about the Holy Grail. Dr. Jones's "grail diary" is included in the documentation. Coffee stains, sketches, cross-outs and all, the diary chronicles Dr. Jones's search and provides key information about the grail's appearance and the three trials that a grail seeker must pass in order to obtain it. Who needs the hint book?

Additional cinematic elements come from the "cut scenes" (short movielike passages) prevalent in Lucasfilm games. This time several of the scenes come straight from the film and manage to pull you even deeper into the action. There's no room in this game for worrying about piddly issues such as money, and it's a welcome improvement.

My criticisms of *Indiana Jones and the Last Crusade* are few.

grail chamber is a definite exception.

I've never thought that playing storyline games more than once was worthwhile, but right now I'm on my third go-around. There are so many ways to approach the challenges in *Crusade* that it would be a shame to put Indy on the shelf after just one try. There are 800 potential "I.Q." (Indy Quotient) points in the game, yet a player can finish with a score of less than 400, bypassing some entertaining hijinks.

Indiana Jones and the Last Crusade is a must for the software library of any self-respecting adventure gamer. Lucasfilm takes the high road to game design with great success. In PC games as in the movies, a strong plot and solid visuals can be more effective than mindless violence or cheap sex-reference references.

List Price: *Indiana Jones and the Last Crusade: The Graphic Adventure*, \$49.95. **Hint book**, \$12.95. **Requires:** 384K RAM, color graphics, DOS 2.0 or later. Lucasfilm Ltd., Games Division, P.O. Box 10307, San Rafael, CA 94912; (415) 662-1902.

CIRCLE 421 ON READER SERVICE CARD



Among the light touches in Lucasfilm Games' *Indiana Jones and the Last Crusade* is a replica of a Seurat masterpiece.

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After Hours

Two Games Produce Great Sound, 3-D Visuals Without Add-on Hardware

GAMES
by Don Ivette

Sight and sound are the "hooks" that add realism and fun to two new computer games that will leave you and your friends eager for more. In *Beyond the Black Hole*, you fly an orb through three dimensions thanks to special glasses and an advanced 3-D imaging technique. *World Class Leader Board* offers what others have tried to provide and failed: intelligible and understandable speech from the PC's tiny 2.5-inch speaker.

The secret of *Black Hole*'s startlingly realistic 3-D imagery is the Pulfrich Effect: a darker image takes a split-second longer to get to the brain than does a light-colored one. This latency is translated by the brain into a three-dimensional view. The glasses supplied with *Black Hole* are equipped with a clear and a dark lens (rather than blue/red commonly used in other 3-D effects). But the Pulfrich Effect works only when objects move continuously, smoothly, and rapidly, so the illusion is best on a turbo PC or AT-class machine. (The game can be played without the glasses.)

At first blush, *Beyond the Black Hole* looks like a souped-up version of the ever-popular *Black-buster/Breakout* games, but you won't play long before you catch on to the differences. The designers have added a dash of subtle humor and some sophisticated puzzles to what would otherwise be just a test of hand-eye coordination.

You are in control of an orb or ball that appears to fly around the computer screen in three dimensions. As in other games of this type, you try to hit objects with the ball. But unlike the other games, you've got to line up tar-

gets in three-dimensional space. It's not easy. The orb can be controlled from the keyboard, a joystick, or mouse, but I didn't make much headway until I switched to the mouse.

The objects you aim at vary from level to level, and often form subtle puzzles. Sometimes the goal is to make objects disappear, while at other times the puzzle is solved by putting objects in a particular order. Each puzzle is based on a familiar saying, and it pays to think about the puzzle before you start to play.

One screen, for example, has pictures of mouths and boats. It is a slogan from World War II: "Loose Lips Sink Ships." After you hit all the lips, a ship sinks; after all ships sink, you advance to the next screen. So far in the course of 35 levels I've encountered a bowling alley ("Up Your Alley"), a pool game ("Behind the Eight Ball"), ducks ("Ducks in a Row"), and an absurd level where you must form phrases



Beyond the Black Hole takes the traditional "Breakout" game situation into three-dimensional space.

realism to an already excellent golf simulation. *Leader Board* includes four courses, three of which accurately reproduce the distances, traps, trees, roughs, and water hazards of St. Andrews, Doral Country Club, and Cypress Creek. The fourth course

wind direction and velocity into account.

By manipulating the joystick or keyboard, you control both the power and the point of contact between ball and club—too soon causes a hook; too late, a slice. Making straight, true shots ("Looks like it hit a tree, Jim") is no easier on the computer than on a real course. Ditto for putting.

To get the excellent sound quality, Access Software employed a professional announcer and used a variety of real sounds. To increase the clarity, the sound track was enhanced using a variable phase-shifting process called "flanging."

To check the results, Access insisted that the recording studio use a 2.5-inch speaker, the same size as in the IBM PC, as a monitor. Finally the sounds were digitized into 400K at three rates to accommodate different computer speeds. The results are worth the effort, or as Jim would say, "From my vantage point, it looks safely in the fairway."

List Price: *Beyond the Black Hole*, \$49.95. **Requires:** 512K, graphics adapter, DOS 2.0 or later. The Software Toolworks, 19808 Nordhoff Pl., Chatsworth, CA 91311; (818) 885-9000.

CIRCLE 424 ON READER SERVICE CARD

List Price: *World Class Leader Board*, \$54.95. **Requires:** 384K, graphics adapter, DOS 2.0 or later. Access Software Inc., 545 W. 500 South, # 130, Bountiful, UT 84010; (800) 824-2549.

CIRCLE 425 ON READER SERVICE CARD



Besides outstanding graphics, *World Class Leader Board* offers the best sound ever to come out of a PC speaker.

from pictures ("Melon-Collie-Baby!").

If you don't know the saying behind a particular puzzle, you may mistakenly hit objects that decrease, rather than add to, your score.

Whether you are listening to the swish of a wood or eavesdropping on the announcers ("Ooh, can't be too happy about that one"), the sounds and voices in *World Class Leader Board* add a wonderful dimension of

is a custom-designed nightmare, appropriately called the Gauntlet. If you tire of these fairways, Access Software has created ten more courses that are available separately.

One to four duffers can slice and hook their way around the links, competing against both par and one another at three skill levels (kids, amateur, or pro). After selecting a club from a bag of 14 irons and woods, you line up the shot, taking factors like

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Actual game screens from IBM PC/EGA version of the game. Other versions may vary.

CIRCLE 115 ON READER SERVICE CARD

After Hours

A Banker's Secret: Your Mortgage As an Investment

PERSONAL FINANCE
by Winn L. Rosch

Save thousands on your mortgage—typically \$34,000 on a \$75,000, 30-year loan. The promise of *A Banker's Secret* is so compelling that it sounds too good to be true—or at least too good to be legal.

Amazingly, it's both legal and true. Follow the outline of the book that accompanies the \$29.95 *Banker's Secret* software disk and you can trim both the expense and length of your mortgage. The "trick" is the miracle of prepayment: Every time you send in your mortgage check, you add a few extra bucks. Through the black magic of compound

interest, those pennies saved add up to a small fortune.

A Banker's Secret generates a number of on-screen or paper charts that help you track your mortgage and plan the prepayments. One of the tables is a customized track-your-payments schedule to follow for the life of your mortgage. A quick missing-value calculator helps you find the right mortgage/prepayment rate to suit your budget. The whole package is controlled by a simple menu interface that even harried home owners can master in minutes.

That said, *A Banker's Secret*

ment is—a special savings plan. Its strength is that your effective interest rate is your mortgage rate. That's probably a few percentage points higher than you could get in a passbook account, about the only other place you could regularly invest the small amounts that *A Banker's Secret* recommends as prepayments.

The shortcoming of *A Banker's Secret* is not that its secret is so obvious. In fact, its clear (if sometimes misguided and somewhat breathless) explanation of loan prepayment is probably worth the \$9.95 price of the book or even the full cost of the soft-

ware. The problem lies in its one-sided presentation of prepayment. Creator Marc Eisenson is a true believer, and to him prepay-

ment is the answer to all the world's ills. But his explanations skate over important issues like leveraging your loan (you get a higher return on your investment when you have a minimum of capital tied up). He totally ignores such concepts as present value (which gives you an exaggerated picture of what you'll really save).

Prepayment can make sense. It can help you better match your budget to a mortgage, letting you create a 23-year payment program even when banks will write only 15- and 30-year instruments. *A Banker's Secret* software charts will help you set your budget on a safe course. But if you have your doubts about whether prepayment is right for you, you'll have to check elsewhere for a balanced view.

List Price: *A Banker's Secret*, \$29.95 (includes \$9.95 book of same name). **Requires:** 128K RAM, DOS 2.0 or later. Good Advice Press, P.O. Box 78, Elizaville, NY 12523; (914) 758-1400.

CIRCLE 423 ON READER SERVICE CARD

You can trim both the expense and the length of your mortgage. The "trick" is the miracle of prepayment.

is not the mystery of the ages revealed. At heart, the real banker's secret is simple—if you save money, you'll have more money.

That's all mortgage prepay-

ment is the answer to all the world's ills. But his explanations skate over important issues like leveraging your loan (you get a higher return on your investment when you have a minimum of capital tied up). He totally ignores such concepts as present value (which gives you an exaggerated picture of what you'll really save).

Prepayment can make sense. It can help you better match your budget to a mortgage, letting you create a 23-year payment program even when banks will write only 15- and 30-year instruments. *A Banker's Secret* software charts will help you set your budget on a safe course. But if you have your doubts about whether prepayment is right for you, you'll have to check elsewhere for a balanced view.

List Price: *A Banker's Secret*, \$29.95 (includes \$9.95 book of same name). **Requires:** 128K RAM, DOS 2.0 or later. Good Advice Press, P.O. Box 78, Elizaville, NY 12523; (914) 758-1400.

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CIRCLE 236 ON READER SERVICE CARD

by
Bill Howard

Abort, Retry, Fail?

The Lighter Side of Personal Computing

GREAT MOMENTS IN SOFTWARE

In 1987, the index in NoWord documentation reached a new record—NOT ONE CORRECT PAGE NUMBER!!



How Well Does It Handle Navy DIF?

"The ReadyNet LAN is a peer-to-peer network, with the first node configured as the file server and the other nodes as workstations."

—Computer Reseller News, July 31, 1989

Oops, maybe peer-to-peer networking is right after all: these Sea World inhabitants are bottle-nosed dolphins, not bottlenose. And, if you look closely, you'll see four, not three.

—LAN Times, April 1989



Three Atlantic bottlenose dolphins thrill Sea World visitors as the latest LAN technology counts attendance.

Oy vey! Software for Passover!

HyperSeder—Removable HyperCard program about the Seder, with dazzling graphics, rich, digitized sound and concise text. So authentic, you can almost taste the Matzah! Perfect for both beginners and veterans of Seders past. \$24.95

When your Mac-happy friends list the advantages of the Apple environment, no doubt they're thinking of such products as HyperSeder, a \$34.95 HyperCard program about the seder, with such memorable ad copy as, "So authentic, you can almost taste the Matzah."

—Dawka Corp., (800) 621-8227.

Classified ad in the Atlanta Journal and Constitution, April 7, 1989.

Priceless Advice (Shutterbug Division)

"Storage memory or random access memory (RAM) will require a hard disk drive, which can be internal or external, and is available in increments of 20, 40, 80 Mbytes and up. The RAM figure limits the amount of data stored on the hard disk drive. Since this is the data available for processing by the computer and software, I suggest you buy a hard disk drive with more RAM memory than you expect to require."

—Photomethods, June 1989



Priceless Advice (Video Division)

"It is also time you started learning about the quality of clones and compatibles. Many of the video boards are very sensitive to the bus speed of the computer. While the 16 bits of a genuine IBM make things very accurate, many of the clones have slop in the system. What happens is that you just can't get things to work right."

—Camcorder Report, August 1989



If You Add These Up and Still Get 3, Then Maybe NuBus Does Slide Into a PC

There are currently three standard types of slots in DOS computers: PC, AT, MCA, and NuBus. The PC slots (also called 8-bit slots) are called such because they first appeared in the IBM PC.

—Personal Computing, March 1989

Without 8-Bit PC NuBus, Those Early ESDI Drives Wouldn't Have Been So Hot

"Another trend in the new servers is the Small Computer Systems Interface (SCSI). Such drives are faster than Enhanced Small Device Interface disk drives, the most prevalent PC disk drive standard—which became nearly universal because it was the approach IBM adopted with its original PC."

—Data Communications, June 21, 1989

PC Magazine offers \$50 and a PC Magazine T-shirt if we use your submission in Abort, Retry, Fail? Warning: Don't write on the original if it might be reprinted, mark up a photocopy or use a Post-it. In case of duplicate entries, the nearest entry wins. Winners this issue: Rob Cox (peer-to-peer), Larry Jansch (dolphins), Elaine DeLeo (HyperSeder), David Rosin (virgin in box), Bruce C. Ruiz (RAM versus hard disk), Richard Q. Fox (slop in the system), Stewart Venit (NuBus), Kevin Sullivan (SCSI versus ESDI).

Technically speaking, the Dell System[®] 325 is one of the most advanced 386[™] computers available.

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we've sold to date, each and every one has been individually configured to fit the needs of its owner.

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can include an optional Intel[®] 80387 or WEITEK 3167 math coprocessor.

And since nothing about this system is lightweight, the standard mass storage is a 100 MB hard disk drive. Or we can configure it with a 40, 150 or 322 MB hard drive.

As you might expect, the output is just as intense. You can choose between VGA Mono-chrome with paper-white screen, VGA Color Plus, or Super VGA

THE DELL 386 SYSTEM 325 HAS A 25 MHz CLOCK RATE, CACHE MEMORY CONTROLLER, IDE OR ESDI HARD DISK DRIVE, PAGE MODE INTERLEAVED MEMORY, AND 100% COMPATIBILITY WITH MS-DOS, OS/2 AND UNIX SYSTEM V.

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For the full story, see inside back cover. *February 14, 1989*

